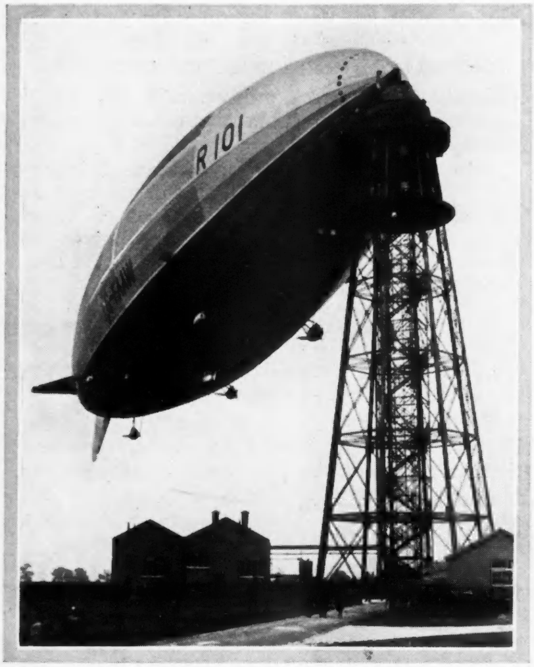
CHRISTMAS NUMBER

DISCOVERY

A Monthly Popular Journal of Knowledge

Vol. X. No. 120. DECEMBER. 1929. PRICE 1s. NET



THE R 101 MOORED AT CARDINGTON.

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Edited by JOHN A. BENN.

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Editorial Notes.

ONE of the most thought-provoking addresses we have lately heard was delivered on 19th November to the British Science Guild by Sir Walter Fletcher. The occasion was the fifth annual Norman Lockyer lecture, and the subject "Medical Research, the Tree and the Fruit." In the course of a wide survey, attention was drawn to the curious fact that on the accession of Queen Victoria, medicine was in much the same position as at the time of Henry VIII. During three centuries which saw such immense advance in the mechanical arts, there was a "relative absence of medical progress having any practical significance in aid of the suffering of mankind." But it is important to remember that throughout the seventeenth and eighteenth centuries, the floods of new light coming from the long line of anatomists and physiologists who followed Vesalius and Harvey, were illuminating the darkness in which physicians and surgeons had hitherto worked. This earlier period of gradual growth in knowledge is too often overlooked at the present time, and there seems to be a wide impression that money has only to be found for the medical profession to discover a cure overnight for any and every disease. How mistaken is this idea was made clear in the lecture we are discussing, the gist of its argument being that fruit can only be obtained from the tree of research by proper care of its roots.

* * * * *

Many common complaints still defy the doctor. Among these the cold and the headache were cited by Professor Boycott in a recent article in our columns. At the same time the development of the medical sciences in the past half century has no parallel in previous history. Even since 1900 the body of facts presented to medical students has swollen two or three times in volume—and in some subjects five times. As Sir Walter Fletcher said, the increase of new knowledge has come so tumultuously and so rapidly as to allow no proper time for the necessary adjustments of the machinery of education. The universities have been embarrassed to make proper provision for this rapidly expanding scientific activity, and for the new branches of work that have made claims to constitute new sciences. The situation is so full of danger to the real educational welfare of the student to-day, that "radical changes in method and scope are obviously required and are overdue." What these changes are was a subject evidently thought to be outside the province of the lecture. It is true that the need was urged for the better endowment of research, but we hope that on another occasion Sir Walter Fletcher will set out his views on this vitally important subject of medical reform. They would be as widely welcomed by the public as by educationalists.

* * * * *

The foregoing paragraph reminds us of another urgent reform. We refer to the reform which would seem to be desirable in the choice of personnel for Royal Commissions. Too often classes of persons closely affected by the outcome of such enquiries are not represented at all. The latest complaint is voiced by a resolution of the British Science Guild, referring to the constitution of the Royal Commission on the Civil Service. The grounds of complaint are expressed so adequately, and in terms which might be applied with equal justice to other enquiries, that we feel it of public interest to reproduce the resolution in full. It reads:—"That having in view the circumstance that the State directly conducts, under its own management, important and highly scientific and technical undertakings, such as the telegraph and telephone services, and also recognizing that

science has to-day a very important bearing upon so many of the problems dealt with in and by Government Departments, the Council is greatly disappointed to find that the Royal Commission on the Civil Service recently set up by His Majesty's Government does not include among the members a single man of science, or one engaged in the application of science to the needs of the community. The Council records its emphatic protest at the omission to appoint upon the Royal Commission a due proportion of members familiar with national aspects of pure and applied science, particularly in view of the fact that an urgent necessity exists at the present time for a complete and impartial review of the status and functions of the considerable body of scientific and technical experts forming part of the Civil Service."

* * * * *

Under the somewhat extravagant title "Why you cannot help it," Mr. J. B. S. Haldane contributed to the November *Pall Mall* magazine an interesting article on the problem of free will. A book called "Crime as Destiny" has been published in Germany by Professor Lange, who, with the help of the judicial authorities of Bavaria and other states, investigated every available case in which a criminal was one of a pair of living twins of the same sex. The outcome of his research is claimed to be that irrespective of different upbring and environment, the behaviour of each twin was discovered to show similar characteristics at some stage in its career. Exceptions are accounted for by one twin marrying a person of sufficient character to restrain inherent criminality. In the cases discussed by Professor Lange, however, differences of environment and freewill together saved only three out of thirteen twins from imitating their criminal brother or sister. The differences were sometimes fairly considerable. Two of the criminal twins had been separated at eight years of age. Another pair, who parted somewhat later, both ran away from their jobs at the same moment when over a hundred miles apart. We must admit that in writing of these remarkable observations Mr. Haldane makes a strong case for further study on similar lines. But it is perhaps to the good that he spoils the startling effect of the theory—which suggests that eighty per cent of our moral decisions may be predetermined—by enlisting in its support the ludicrous fact that the same pair of twins—after running away from their jobs—"developed acute appendicitis on almost the same day when even further separated"!

* * * * *

A human voice was heard and seen simultaneously by members of the New York Electrical Society on 6th November. Other effects for which novelty is claimed were also demonstrated by the lecturer, Mr. J. B. Taylor, of the General Electric Company, whose address was entitled "Super-speeded speech." This latest phenomenon consisted in greatly increasing the rate at which normally recorded speech is reproduced. The sound portion of a talking film was used and as the speed of the reproducing apparatus was increased, the voice was heard in a higher pitch and much more clearly. At one hundred per cent above the normal pace the words ceased to be intelligible, and a high musical phrase resulted. For the visual experiment Mr. Taylor projected the sound track on to a screen, where it produced an image of the voice, made up of varying bands of light and shade. Through a slot in the screen these variations were caught by a reflector working a light-sensitive cell, which in turn worked a loud speaker. In this way the image on the screen was the controlling element in reproducing the voice and other sounds.

* * * * *

We are now able to give further details of the articles on "British Universities To-day," which will appear in *Discovery* during 1930. In the first article (January) Professor A. C. Seward will deal with Cambridge, to be followed in February by an account of Birmingham from the pen of Sir Charles Grant Robertson. Other contributors will include Dr. Edwin Deller (London) and Dr. W. M. Childs (Reading). The object of the new articles is to discuss the governing policy of the universities and to estimate their most notable influence on modern life. Since publishing a preliminary announcement last month, we have received several comments on the boldness of a plan which proposes to deal in these pages with a subject at once so vast and controversial. Now that the names of the first contributors can be printed, this criticism has less weight, but we should perhaps point out that each article will express the opinion of its writer—which is not necessarily that of *Discovery*. Having seen the first manuscript, we can safely predict a warm welcome for the series, which will provide a survey, not hitherto attempted, of what is perhaps the most important branch of our national life.

* * * * *

It is reported from Russia that a pair of fossilized brains, believed to be the oldest ever found, have been unearthed near Moscow. They were discovered in conjunction with the teeth of a mammoth and are said to be sufficiently well preserved for anatomists to reconstruct their original form. A preliminary study suggests that these cave men possessed a brain smaller than that of their descendants.

Scientific Aspects of the R 101.

By J. L. Nayler, M.A., F.R.Ae.S.

Secretary of the Aeronautical Research Committee.

Much has appeared in the newspapers about the first flights and policy of the new British airship, but its scientific aspects are not yet familiar. Our contributor discusses the R 101 from this important standpoint.

It is perhaps only during the present year that most people have realized that airships are not merely gasbags, a term of contempt applied equally, by those who do not know, to all types of balloons and airships. A marked change has resulted from the excellent performance of the Graf Zeppelin, which has flown successfully round the northern part of the globe, but there still lingers in some minds a sense of insecurity in regard to abnormal weather and to the natural care taken in the handling of R 101 after it was first taken from its shed. The attention of the British public has been so closely focussed by the newspapers on the new airships R 100 and R 101, that it has been apt to forget the like care taken with new designs of transport vessels, such as the preliminary trials of a new liner or even the running-in of an ordinary car engine. These are directions in which there is a large basis of experimental knowledge on which to build, whereas the R 101 must be regarded as the first airship of its type. As a consequence it is experimental and represents a mode of transport which is still in its infancy.

The Question of Strength.

Most readers are acquainted with Zeppelins and with the British airships R 33 and R 34, which closely followed the same design. For convenience of construction these ships had a shape with a large amount of parallel portion in the body; that is to say, the shape was more nearly that of a cigar than that of an egg. The ratio of length to largest diameter or fineness ratio was about 8 : 1. An appreciable change in appearance will be found by comparing, say, the R 34 (a sister ship to R 33), which flew to the United States and back in 1919, with the R 101, as the new ship has a fineness ratio of $5\frac{1}{2}$ to 1 and has, as a consequence, an appearance not unlike a fish. The shape of the new airship has also a steady change of curvature so that none of the longitudinals, which are the long girders running from the bow to the stern, are straight for any part of their length as has been the practice in Zeppelin design. This feature has added to the difficulty and cost of manufacture, but there seems to be little doubt that R 101 is as strong in all respects, and much stronger in a few respects, than any previous design of airship, and at the same time has a smaller resistance for its size, the shape being ingeniously maintained by a system of tightening girders which put a tension in the covering envelope. To explain the question of strength, attention must be drawn to certain matters affecting the strength of all aircraft.

Mathematicians have methods of calculating the strength of any engineering structure which are quite well known. Most structures are what are called redundant structures; that is to say, there are more component members to the structure than are needed to give it stiffness. A square ABCD (Fig. 1) made of four rods pinned together at the corners can be made into a stiff structure either by the addition of another rod between A and D (or B and C), or by the use of wires in tension between both B and C and A and D. Both these elementary structures are non-redundant, but if in the first case there are rods connecting AD and BC, the structure would be redundant and allowance would have to be made in strength calculations for this addition. This is a relatively simple matter. Now in calculating the strength of a bridge the designer omits in his first estimates of strength certain of the less important members (struts, etc.), so that the structure has no redundancies and then allows, by more complicated methods, for those parts he has not considered. Such calculations are difficult, but they are simple compared with the problem that awaits the designer of an airship with its numerous girders, these themselves of complicated construction, and the hundreds of wires (see Fig. 3). Theoretically any redundant framed structure can be analysed completely by mathematical methods, but in the case of the airship the solution of so many simultaneous equations would be required that the actual labour involved is

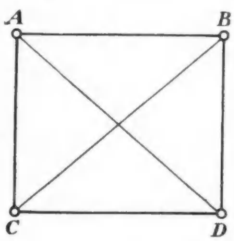


Fig. 1.
STRUCTURAL DIAGRAM.

prohibitive, if not impossible. The Airship Stressing Panel of the Aeronautical Research Committee realized this fact when they investigated methods applicable to the design of airship hulls, and laid down some new methods which were both possible and practicable ; they, however, needed checking. Professor A. J. Sutton Pippard, a member of the Panel, undertook the necessary experimental work at University College, Cardiff (University of Wales), where he erected a structure of rods and wires such as is shown in Fig. 2. This structure was made of steel tube 7/8-inch outside diameter and 22 gauge thick, and was put together by pin joints in the form of a hexagon of three bays with a fourth bay in the form of a regular pyramidal nose-piece. The structure was attached by dowels to mild steel plates bolted to a main wall of the laboratory. To test out the theoretical work weights were hung on the nose-piece and at different points of the structure for various arrangements of the possible methods of wire bracing. The results were satisfactory in substantiating the method of stressing laid down by the Airship Stressing Panel, and a casual glance at Figs. 1, 2 and 3 will show that the hexagonal structure used by Professor Pippard can be considered as a half-way house between the elementary square and the complicated airship structure. Prior to these remarkable compared with the Zeppelin type of construction with its innumerable rivets, as the former has many of the advantages of a " Meccano " set.

As a check on an entirely novel design Colonel Richmond made the tests shown in Fig. 3. Here we see the whole structure and gasbag netting system surrounding one of the largest gasbags, and our photograph gives some idea of the complication of the structure from the designer's point of view. It shows the triangular method of construction used in the ring frames without radial bracing, whereas the Zeppelin pattern had such bracing. There are in all fifteen such frames in R 101, the majority of which are of the novel type of structure, with the first two frames and the structure aft of frame fifteen of conventional Zeppelin type, girder work of duralumin. These ring frames are connected by fifteen main and fifteen intermediate longitudinal girders running along the length of the ship. The form of the ring frame has thirty sides, and this cross section is changed between frames twelve and thirteen, just forward of the fin structure at the back, to a polygon of thirty-two sides, which number being divisible by four is more suitable for the attachment of the tail organs. The gasbags between each pair of transverse frames are

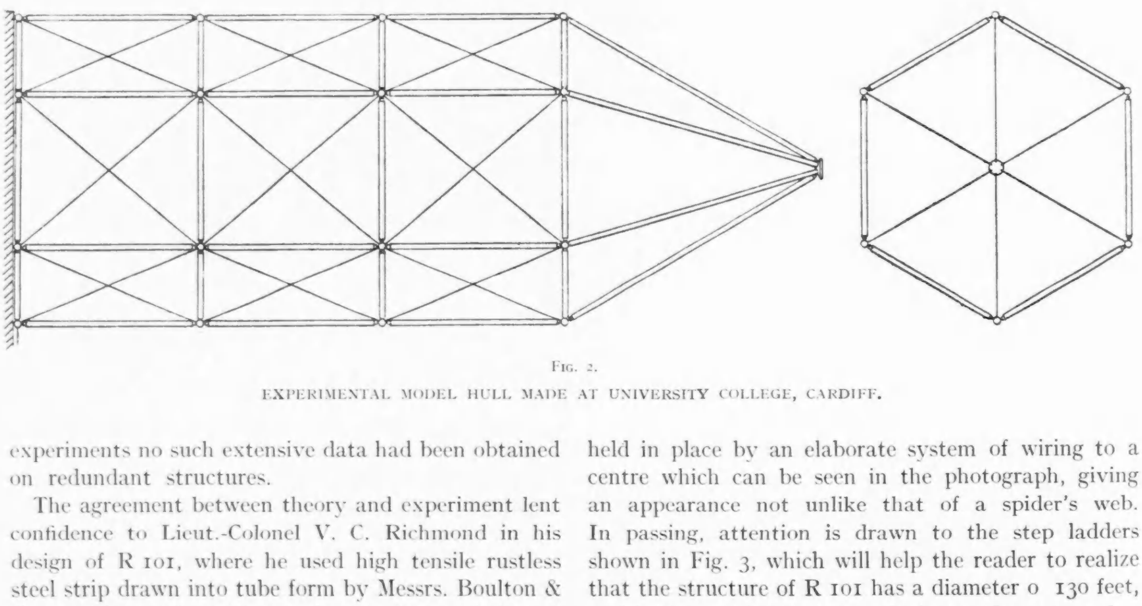


Fig. 2.
EXPERIMENTAL MODEL HULL MADE AT UNIVERSITY COLLEGE, CARDIFF.

experiments no such extensive data had been obtained on redundant structures.

The agreement between theory and experiment lent confidence to Lieut.-Colonel V. C. Richmond in his design of R 101, where he used high tensile rustless steel strip drawn into tube form by Messrs. Boulton & Paul of Norwich, with duralumin webs and forged duralumin end fittings, all attached to pin joints for ease of erection of the airship and facility of stress calculation. The rapidity of erection was

held in place by an elaborate system of wiring to a centre which can be seen in the photograph, giving an appearance not unlike that of a spider's web. In passing, attention is drawn to the step ladders shown in Fig. 3, which will help the reader to realize that the structure of R 101 has a diameter o 130 feet, and is thus with R 100 greatly larger than any other airship yet constructed.

To design an airship structure to have a factor of safety of four for most of the conditions of flight,

in accordance with the requirements of the Air Ministry for airworthiness, it is essential to know to what forces the ship will be subjected when in flight or moored at a mast. Two lines of research have here aided the designer, the first a determination of the aerodynamic characteristics and the other a knowledge of the pressure of the wind over areas commensurate with the size of the aircraft. In a National Physical Laboratory wind tunnel the pressure at different points on a model has been found and compared with measurements made in flight on the R 33. This showed that for future designs the model experiments could be taken as a good guide of what is actually found on the ship itself, and consequently the pressures were similarly measured on a model of R 101 during the time that the details of design were being settled. A knowledge of the possible changes of wind over the ship under varying conditions, especially when moored at a mast, has been gained from the records of four anemometers mounted on masts 50 feet high and placed at the corners of an equilateral triangle with sides of 700 feet and in the centre of one side. Some of the information on wind structure gained by this means by the Staff of the Meteorological Office has already been published at last year's meeting of the British Association, and has provided the link required to connect experiments made at a constant wind speed in a wind tunnel with the actual conditions experienced by an airship in flight and when moored.

With a knowledge of the forces to be experienced in flight the distribution of the static loads could be arranged so as to make the best use of the structure weight. In R 101, the main loads are those of the passengers, who are accommodated as nearly as possible in the centre of the ship, and the engines which are suspended, two from frame four, two from frame nine and one from frame eleven. The ability of the airship to withstand large upward currents is also much greater than in previous ships, being designed to withstand a vertical gust of 45 m.p.h., a condition only experienced in the tropics; previous airships were designed to a figure of 15 m.p.h. only.

In addition to the above wind tunnel research, the National Physical Laboratory has, from an extensive series of experiments, given data for the shape of the hull used and the proper size and proportions of the fins fitted, both as regards stability in straight flight and when turning, and the amount of control to be expected from the movement of the elevators and rudders. It is understood that Major Scott has expressed entire satisfaction with the handling of the ship under the conditions to which it has been subjected up to the time of going to press, including a short

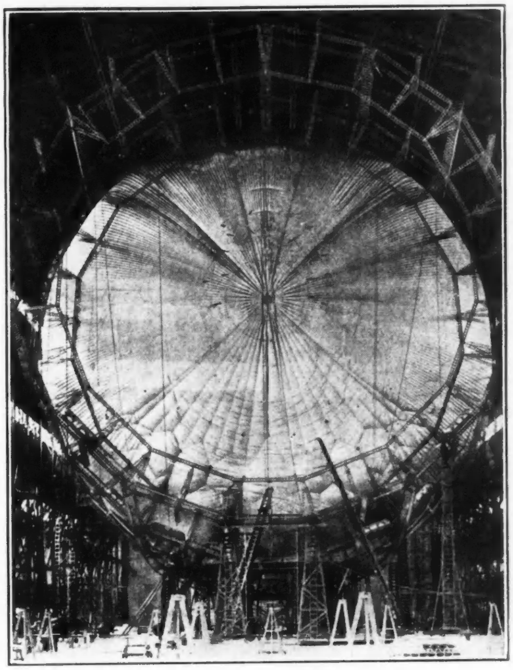


Fig. 3.

NETTING SYSTEM SURROUNDING ONE OF THE GASBAGS.

This photograph should be viewed in relation to the line diagrams. It shows the triangular method of construction used in the ring frame without radial bracing. (By courtesy of Royal Aeronautical Society.

period at its maximum speed of 70 m.p.h. The ship has ridden safely at the mast in a wind with gusts up to 83 m.p.h., and through a line squall with a wind charge of 135 degrees with one minute.

It will already be realized by the reader that much research was devoted during the four years prior to the launching of R 101 to problems affecting the design and performance of the airship, but we have as yet said nothing about the engines which have provided many new problems needing solution. The new compression-ignition (Diesel type) engines built by Messrs. Beardmore are of the eight cylinder-in-line type, and burn a heavy fuel oil instead of petrol. Safety and not cheapness has been sought by the use of this fuel which does not give rise to a highly inflammable and explosive mixture such as petrol and air. Wing-Commander T. R. Cave-Browne-Cave, who is the officer responsible for the machinery installation of the airship R 101, has demonstrated the non-inflammable properties of the fuel oil by using it to put out the flames from a large dish of burning petrol. There is an important advantage in the use of this fuel, and that is the much smaller quantity needed for a long voyage compared with petrol.

As a disadvantage the weight of the Beardmore "Tornado" engine is considerable, as it amounts to about 6-7 lbs. per horse-power, which is high compared with a petrol aeroplane engine of 2-3 lbs. per horse-power. In spite of this difference, the total weight of the heavier engines plus fuel is less for a journey of 2,000 miles or more than the corresponding petrol engine with its fuel.

As the first engine of the compression-ignition type to be built in this country, Messrs. Beardmore experienced with the "Tornado" a number of what may be called "teething troubles," amongst which may be mentioned the injection of the fuel and the torsional resonance of the long crankshaft; the latter has involved considerable increases in weight in order to get additional stiffness in the shaft, in the crankcase and elsewhere. The starting of the "Tornado" engine is made by an auxiliary engine of 40 h.p. through a reduction gear of 20 : 1. The five engines are accessible in flight for small repairs and adjustments, and are located each in a body or power egg placed outside the ship, four in two pairs of nacelles forward and aft of the centre part of the ship and with airscrews driving forwards, and the fifth in a centrally placed nacelle near the tail with arrangements at present for giving power astern only. A novel system of evaporative cooling, by the air, of steam condensation is successively used in flight. The cover illustration elsewhere shows two of the wing power units and the fifth towards the tail. The other projection forward of the centre of the ship is the control cabin, where are stationed the officer in charge of flying, the coxswains for the horizontal and vertical rudders, and controls for signalling to each of the engine cars.

At the bow there is a special fitting rigidly built into the structure of the airship, to which the mooring rope is attached prior to mooring and which when hauled in enables the nose cap to be locked into the small rotating head of the mast. A good sense of proportion is given by the photograph and the reader must remember the scale of everything shown, with a mast 220 feet high and an airship over 700 feet long with a maximum diameter more than half the height of the mast.

The practical use of the airship has not been forgotten, but the writer has deliberately drawn attention first to the many interesting scientific problems associated with the design and operation of the largest airship yet flown. We can get some idea of its relative size by comparing in a small table the R 33, the Graf Zeppelin, and R 101. (Fig. 4).

	Length. feet.	Diameter. feet.	Maximum speed. m.p.h.	Cruising speed. m.p.h.	Range. miles.	Passengers.	Capacity (million cu. ft.)	Displacement. tons.	Engines. H.P.
R 33	640	79	52½	40	3,000	—	2	60	5 × 250
Graf Zeppelin ...	772	100	80	70	6,000	20	3·7	107	5 × 530
R 101	732	132	70	63	3,000 to 4,000	50-100	5	151	5* × 585

* One used astern only (at present).

FIG. 4.

COMPARISON OF THE R 101 WITH R 33 AND THE GRAF ZEPPELIN.

We see from the above that the progressive increase in size is largely that of diameter, so that the R 101 has almost the same bulk looked at sideways as the famous British liner *Mauretania* when completely out of the water. Owing to this increase the accommodation for the passengers has been enormously improved, and we may well say that the time is approaching when real comfort in travel accompanied by speed will be attained. Even after making allowance for the enthusiasm of those who have already flown in the ship on its early voyages, there seems to be little doubt that the vibration and noise are less than in an Atlantic liner or an express train, that the movement in the air, except just prior to mooring, is so slight as to be hardly noticeable and that ventilation and heating are adequate. The saloon, dining and sleeping accommodation compare well with the liner, even if some allowance has to be made for the first ship of a type, and what surprises everyone is the "roominess." The speed of travel for long distances cannot be surpassed except by aeroplanes, whose standard of comfort does not approach that of the airship. The reader will now ask what is missing. It is that there is no direct sunlight, for since the passenger accommodation is situated along the bottom of the ship, the panels in the hull cannot be made sufficiently high for this to be possible. At present the difficulty would appear insurmountable, but we may repeat that the design of large passenger airships is still in its infancy. There is a lounge capable of seating one hundred people in comfort, a smoking room to seat thirty persons, and a dining room in which fifty meals can be served from an electric kitchen located below it.

A Medieval Scholar in Action.

By Helen Hughes, M.A., Ph.D.

New light on English life of the fourteenth century is forthcoming from the sermons of a church leader who was for some time Chancellor of the University of Oxford. The writer has studied these unpublished documents which indicate how wide were the interests of a " man of affairs " six hundred years ago.

THE extravagance of the praise and the blame which are commonly bestowed upon the church of the Middle Ages are an unwilling tribute to its importance, for " the medieval church is the mother of us all," and we all have an interest in its life, whether we realize it or not. Nothing could throw more light upon its true character than to know how its leaders really lived and thought, and how it actually influenced its members in their daily life; but it is obviously difficult to obtain detailed knowledge of this sort, and we have to trust mainly to methods of self-revelation intended primarily for another purpose, such as sermons and letters, which were often kept or recorded if they were known to be of importance.

A Zealous Reformer.

Collections of sermons by one man are a good source of biographical information, especially if they are recorded with the date and place of their delivery; for a man whose preaching is well thought of must be a power in the land, whether justly or not, and the sermons themselves, when afterwards read, reveal more than he is aware of what he thought himself, as well as what he wanted his hearers to think. There is such a collection of sermons by one of the most notable leaders of the church in the fourteenth century—Richard FitzRalph, Archbishop of Armagh. He was a zealous reformer, and strongly influenced his younger contemporary, John Wyclif; but FitzRalph himself always remained orthodox, and was beloved and respected not only in his own country, but in England and at the papal court in Avignon as well. From these sermons his rich and vivid personality stands out—scholarly, generous, shrewdly practical—and we can see revealed in his own words a man who did the many-sided work of a medieval prelate.

The exact date and place of his birth are not known, but probably he was born at Dundalk about the year 1300. He belonged to a large family of FitzRalphs, or " Raufs," Brisbones, and Dovedales who lived in that neighbourhood, and seem to have been people of some substance, but of no particular distinction. Several of them are mentioned as having helped the Sheriff of Louth to put down a marauder in such a fashion that their energy was recognized and covered afterwards by the royal pardon; several joined the Franciscan order; others often acted as attorneys for their relations and friends, and sometimes on behalf of foreign landowners in Ireland, such as the Norman Abbot of Lonlay. They were all, it seems, men who could " flourish staff or pen and deal a wound that lingers."

Richard FitzRalph must have gone to Oxford soon after 1315, for it took sixteen years to become a doctor of divinity, and he is so styled in 1331. In the next year the University showed its opinion of him by making him Chancellor. Two things in his Oxford career were important: his friendship with Bishop Grandison of Exeter, and his connexion with the great Stamford Schism. His good fortune in meeting Grandison he probably owed to his poverty, for even after he became a fellow of Balliol he seems to have found it necessary to earn some money while he went on with his studies. FitzRalph became tutor to a young student, John Northwood, who was Grandison's nephew, and so came into contact with the Bishop. A warm friendship sprang up between them. Grandison was also the trusted friend of three successive Popes—John XXII, Benedict XII, and Clement VI—and he was able to give FitzRalph a footing in the papal court at Avignon which determined much of his later career. For more than fifteen years he gave the younger man his constant advice and help, and after FitzRalph had become an archbishop, he sent Grandison a graceful and practical token of his affection, in the shape of one hundred quarters of corn from his manors in Ireland.

The Stamford Schism.

FitzRalph's connexion with the Stamford Schism was less happy. In the autumn of 1333, a great number of northern students fled from Oxford, and tried to set up a rival university at Stamford, declaring that Oxford was too full of danger to life and limb, owing to the constant unbridled rioting of students and townsmen, to be a place of study. They seem to have done their best to make it as dangerous for

the Chancellor as it was for themselves, for in December, 1333, Congregation found it necessary to pass a stern injunction against violence to his person. Exactly what part he played in the quarrel is not clear, but despite all that the university could do, the schism was not over when FitzRalph's term of office came to an end in 1334. Whether he was disgusted with the condition of Oxford, or whether the university thought him too much of a firebrand cannot be told, but at this point he broke off his academic career, and turned to administrative work instead.

A Christmas Dinner.

A few years later he became Dean of Lichfield, and the main series of his sermons begin about 1338, when he was obliged to spend several years at the papal court, transacting legal business on behalf of his chapter. The chapter of Lichfield was an active one. The cathedral was being repaired, with the advice of an architectural expert from London (much of the present building dates from this time); and the cathedral statutes and the chapter act-book show that the staff were expected to take their routine duties very seriously. If the Dean were absent on the days when he was due to say office he had to entertain his colleagues with some ceremony, and FitzRalph found himself obliged to give a Christmas dinner to the whole choir and chapter when he was abroad in 1338. Apart from such burdens, he seems to have grown thoroughly weary of his exile, though he testifies to the substantial justice of the papal court; and he says explicitly that he had already come to look upon preaching as a chief part of his work.

He was not above falling into the faults that so easily beset preachers in all ages, but his sermons were often very much to the point; he addressed Dominicians, Franciscans and Carmelites on the peculiar opportunities and difficulties of their respective orders, and did not scruple to rebuke the dignitaries of the papal palace for luxury and place-hunting. At length he concluded his business successfully, and described his relief in a sermon preached at Avignon in December, 1344. After telling a story of a hair-shirt miraculously mended by St. Mary, he goes on: "Indeed, I feel that this shirt of my mind is now torn and unravelled by the cares and anxieties and distractions of the lawsuits of this palace during the course of many years; let us pray, therefore, that this shirt of mine may be mended and sewn up by that same Virgin Mother of God, in order to inspire my devotion; so that for our common good the word, which is the sword of the Spirit, as the apostle says, may run its course unhindered by fear, and may open the door of our hearts, and that I may be restored to my proper duty as a faithful preacher."

When FitzRalph got back to Lichfield in the spring of 1345, he threw himself into this duty of preaching, not only in the cathedral, but also in other churches in the town, and occasionally in small country places round about. But he was not to remain long in England. By this time he was a man of some position, and had a good reputation at Avignon, as well as in his own country. It is therefore not surprising that when his native diocese of Armagh fell vacant in 1346, he was appointed to it simultaneously by papal provision and by election of the chapter of Armagh. He did not return to Ireland at once, for ecclesiastical appointments, then as now, were a long process; in the meantime he went to London and preached there three sermons at public processions, when special prayers were offered for the King and Princes, who were engaged in the siege of Calais after the triumph of Creçy. In July, 1347, FitzRalph was consecrated in Exeter Cathedral by his old friend Bishop Grandison, and by the Bishops of Salisbury, Bath and Wells, and St. Asaph. After the service, according to the custom of the papal court in Avignon, he rode through the streets of the city, dressed in full pontificals, and mounted on a horse draped with a white cloth. For several months after this he remained in the diocese of Exeter, acting as assistant to Bishop Grandison, and finally he went back to Ireland in the spring of 1348.

Heresy Hunting.

For his first sermon at Dundalk he used a fine discourse on the Lord's Prayer which he had formerly delivered in London, explaining that he chose that subject "because according to the example of Our Lord, Who taught that prayer first to the Jews of His own blood, I wished to teach that prayer first to my kinsfolk." Twenty-nine sermons preached in Ireland, and probably two more, have been preserved; ten or eleven of these were delivered at Drogheda, where there was a palace belonging to the see of Armagh, which was presumably the Archbishop's headquarters. His duties included not only the obvious work of preaching to the people and training and supervising the clergy, but also heresy-hunting (under orders from the Pope), defending his flock against raids and slaughter (under orders from the King), and attending Parliaments and Councils in Dublin, besides managing the estates of the see so as

to secure an adequate income. The position was complicated by an age-long dispute between the archiepiscopal sees of Dublin and Armagh as to which carried with it the primacy of all Ireland, which had now reached a stage when it turned upon the symbolical assertion by the Archbishop of Armagh of episcopal rights in the diocese of Dublin. The result was that if the Archbishop of Armagh failed to arrive at a Parliament in Dublin with his episcopal cross carried erect before him, he might be held to have given away a point of principle for which his predecessors had fought for years; and the opportunities for a ruction which this situation offered to the followers of both parties hardly need to be suggested.

The Black Death.

In the spring of 1349, the Black Death reached Ireland, and created special difficulties about communication with England and the Continent, since, as FitzRalph said, it was "more prevalent in seaside places than in open country or in the hills, and amongst fishermen and sailors more than in men of other professions." Altogether, his first year of office was enough to depress the new Archbishop a good deal, and it is not surprising that when he preached at Drogheda in March, 1349, he adjured his hearers to pray for help: "It is very clear that in our present need, grace is necessary for us all, because of the overwhelming pestilence, because of the abounding malice of men, and because of our lack of wisdom, who are far from any university."

In the summer of 1349, FitzRalph again went out to Avignon, being commissioned by the King to ask for a special grace of pardon for his people in "the isles of the sea" for the Jubilee Year, 1350. The Archbishop was officially speaking both for England and Ireland, but naturally he described most graphically the troubles of his own country, which were fresh in his mind. It is interesting that he ranks the plague as only one amongst many distresses, and though he several times alludes to the poverty of the country, which he attributes partly to the national character, it is racial animosity which seems to have impressed him most. The Scots and Irish, he says, are "always at loggerheads with one another, and hostile to the English. . . . Directly there is a chance, they despoil and kill one another, so that I do not believe that anywhere in the world, at any rate amongst Christian people, so great a multitude perishes out of a like number of people." He points his observations with the tale of a man who once asked the Devil where most people were damned, to which the unhesitating reply was that it was in Ireland, because "there men habitually rob, and never repay one another, and so they perish without true repentance. There, too, the nations always hate one another, and so men die without charity and grace." Of the national incapacity for saving, he says: "Men save little, because through a generosity which seems to be inborn in them, they live sumptuously in the matter of food and drink, and everything that they can get hold of goes into their stomachs and vanishes in the closet."

This visit to Avignon had been authorized by the King as an errand of mercy, but when FitzRalph's mission was fulfilled, he evidently expected him to return, and was very angry that he lingered in Avignon. In the autumn of 1349 certain of the Archbishop's privileges were revoked by the King's orders, and in February, 1350, he wrote FitzRalph a peremptory letter, telling him to come back at once and look after his people. Meantime, the Archbishop had been drawn into momentous business at the papal court. An embassy from the Armenian Church was there, discussing the possibility of reunion, and FitzRalph evidently made friends with the eastern Bishops; very likely he had met them, or some of their fellows, on earlier visits to Avignon. He became deeply interested in their problems, and wrote a book on them, "De Quaestionibus Armenorum," in which he set forth the benefits of rejoining the Catholic Church. (He must have been something of a student of comparative theology, for he not only knew the position of the Armenian Church, but had some acquaintance also with the text of the Koran.)

Reform of the Friars.

At the same time, he was asked to take up the cause of the secular clergy of the whole church in their quarrel against the mendicant friars. This was an old dispute, which had originated in the inevitable friction between two bodies of men who were trying to do the same work—the parochial clergy and the friars—and it had boiled up and died down again periodically in England, France and Italy for about a hundred and fifty years. During that time, it had attracted to itself a good deal of philosophical theory, and it was now in a condition when it could only be handled effectively by a man who understood both the working of a parish and the philosophy of Aristotle; so that when FitzRalph was asked to take it up he remarked that the discussions at Avignon so far had only scratched the bark with thorns instead of digging up the roots with ploughshares. He first of all stated the practical aspect of the difficulty in a sermon preached on 5th July, 1350, in which he begged the

Pope to effect a thorough reform of the mendicant orders; and he then proceeded to write a book on the fundamental questions involved, which he called "De Pauperie Salvatoris."

FitzRalph was able to convince Edward III that his work on these matters was of sufficient importance to justify his absence from his diocese for a time, for in October, 1350, he was given leave to stay some months longer. After his return to Ireland, he was employed by the King on business which showed his confidence in the Archbishop, for when Odo O'Neill appeared with an Irish army before Dundalk, it was FitzRalph who was hastily summoned to "meet and treat with" him. For five years FitzRalph struggled alternately with the practical problems of working his diocese and the theoretical problems of poverty and authority, and when his book was finished he sent it to his old university of Oxford, as well as to the Pope, for comment. About the same time, in the summer of 1356, he was obliged to go over to London on business, and found that the squabble between seculars and friars had burst out there again. As the author of the latest book on the subject, he was invited to preach on it at St. Paul's Cross; and so began the last great battle of his life. To FitzRalph, as a responsible secular, the activities of the mendicant friars seemed a crying scandal, and it is not difficult for a man of vigorous character to find hard things to say of a band of professional beggars. His attack was never merely scurrilous, but it was the fighter, rather than the scholar, who spoke now, though his words had all the weight of scholarship behind them: "I am amazed that they have the face to teach Christ's people such absurdities!" he exclaimed in one sermon. His words stung the friars into action. They drew up an appeal summoning him to answer their charges before the papal court at Avignon, and one John of Arderne, Prior of the Augustinian friars of London, delivered a copy of this appeal in person at the door of FitzRalph's lodging, explaining to the servants who stood by what it was, and handing it to one of them, who promised to give it to his master.

A Royal Decree.

Then the King, who disliked appeals to the Pope, intervened. He sent letters to the sheriffs of London and the mayors and bailiffs of most of the south-eastern ports ordering them to see that "no religious nor anyone else, nor any friar of the Augustinian order" crossed the sea into foreign parts without special royal licence, and also addressed a letter to FitzRalph himself forbidding him to leave the country without permission. What happened next is not clear. At the end of the book "De Quaestionibus Armenorum," there is a kind of prayer or thanksgiving for the mercies of God throughout the author's life which sometimes throws light upon his history; but it is obscure, because the date when it was written is uncertain, and it is very properly cast in an allusive form, and not as if it were intended to convey information. In this prayer occurs the following tantalizing passage: "Thou wast the right way to me when I fled and must hide from the face of the royal officers, who in different parts of the kingdom had received many of the letters called writs, ordering them to take and hold me; for Thou didst now give me inward warning to flee, and now give me outward direction whither I should go, anticipating their wiles, and at length through Thee, the most perfect Way, didst bring me far more quickly whither I would go, avoiding the road considered shorter amongst men."

The Last Journey.

The words suggest that FitzRalph made his last journey to Avignon by some unorthodox means, but there was room in his stormy life for more than one such adventure. In any case, he got there somehow before 8th November, 1357, for on that day he once more stated the case for the seculars in an eloquent sermon, which was afterwards widely circulated as the "Defensio Curatorum." The Pope now was Innocent VI, with whom FitzRalph probably had no previous personal connexion, and it is doubtful whether any Pope of the fourteenth century could have carried through the high-handed reform of the mendicant orders which the Archbishop demanded; but the case was too well defended to be quashed. It was accordingly handed over to a commission, who dealt suitably with it for the next three years; FitzRalph seems to have lived at Avignon in honour and comfort while the discussions went on, but he died before any decision was reached, in the autumn of 1360.

It is not easy to estimate the significance of such a life; the natural result of FitzRalph's association with the attack upon the friars, followed by Wyclif's use of his writings, has been that his name is scarcely ever mentioned in any other connexion, and not often in that. But probably to FitzRalph himself this dispute was only an incident in a varied life. The best witness to the power of such a man is what his contemporaries thought of him, and it is clear that they were not indifferent. His enemies found him worth hating, and tried to destroy him; his own followers, when he died at Avignon, carried him back to Ireland for burial, and there he was known for generations afterwards as "St. Richard of Dundalk."

Fishing in the Niger Delta.

By J. M. B. Homfray.
Assistant District Officer, Nigeria.

The sea fishing of the African negroes was described in DISCOVERY *last June. We follow this with an account of the equally interesting methods employed on inland waters, illustrated by the writer.*

THE negro is associated in the minds of most people rather with hunting elephants and other big game than with fishing. In fact, the negro of fiction usually inhabits South and East Africa, and is represented by the warrior type armed to the teeth and thirsting for blood, brave and spectacular, ready at the command of his Impi leader either to charge a square of well-armed troops, or to sit down and wait with his back turned contemptuously to the withering fire of the enemy's machine-guns, till the medicine-man shall have obtained the favour and blessing of the gods!

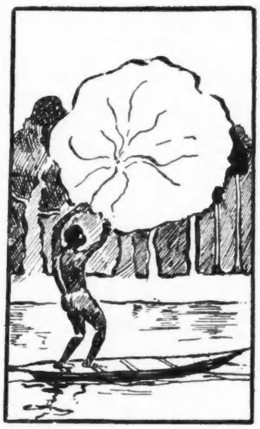
Fearless Sportsmen.

The humbler but much more numerous negro of West Africa is passed over. He is brave in another way, fearlessly he will attack big game almost alone and armed with no better weapon than the uncertain flint-lock dane gun. Close to the coast nearly all the big game has been killed off and hunting takes a minor place, whilst the hunter turns his attention to fishing.

It is perhaps in the Niger Delta that conditions are most promising for the fresh-water sportsman. There he can fish in the Niger River and its numerous mouths at all times of the year, and when it overflows its banks, as it does annually, he can fish either from his doorstep or from the edge of his waterlogged yam farm. Not content with this, a glutton for fish, and a born economist, he must get the very last fish when the waters retreat. To achieve his object he builds a close fence of split midrib of palm (often erroneously called bamboo) across every single water-course or sunken pathway on his land, and on his neighbours' as well (if he feels powerful enough to litigate about it). These fences are often as much as fifty feet long. Into them are cunningly inserted cone-shaped traps made of the same substance, in which the fish become wedged by their scales. Where the streams cross paths the soil is heaped up on one side to make a bank, and in this holes are made and traps inserted, and when the water sinks still further ditches and channels will be cut across the paths so that not even the smallest fish is missed.

Great pits are dug in the land during the dry season and are filled by the floods; these huge traps, for so they are, will be full of fish when the waters ebb. They will be fished in first with nets and spears, and finally the very water will be bailed out till the fish lie gasping and flopping about in the slime at the bottom. These ponds are most jealously guarded; they may lie many a mile from their owner's house, and if so are put in charge of a friendly neighbour who will receive his reward in due course. Many ponds are natural and are usually the result of old watercourses becoming silted up at the lower end. The first person to make the discovery claims the whole pond as against all the world, however small a community he may represent, but as these ponds are usually long and narrow his neighbours have probably discovered the pond at the same time. If they meet either they quarrel and fight or come to an agreement, in both cases there is invariably a court case sooner or later, in which most extraordinary assertions are made, and right of conquest is seldom accepted. A settlement is often arrived at by arranging for one party to fish with one kind of tackle only and the other with another, the final bailing being done by the party having the stronger claim.

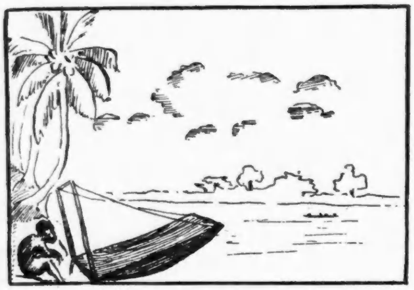
African methods of fishing, though effective, can hardly be described as sporting. By far the most spectacular is the casting net, which the men themselves make at home either out of imported thread from Europe or from the fibre of certain plants. This net is circular and has weights around the edge, and the centre is attached to a long cord, the free end of which is held in the left hand, the loose folds being coiled round the left wrist. The centre of the net is held in the right hand, and the net is wound spirally a few turns before casting,



THE CASTING NET.

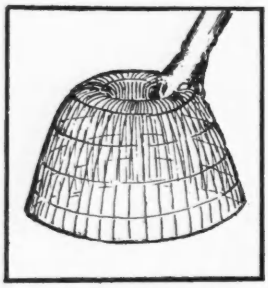
just as an umbrella is wound when out of use. When the net has thus been trimmed the fisher swings it two or three times round his head so as to generate the necessary centrifugal energy and then releases it. The net then flies upwards at an angle of about forty-five degrees with the weights to the front, and begins to untwist its spirals. By the time it reaches the water it has spread itself out in a complete circle some five yards from the thrower. The weights, of course, sink first, and the centre remains on the surface, thus the fish are imprisoned as though in a diving bell. The net is recovered by pulling in the cord, and it rises slowly from the water holding a shining silver fish at least one throw in every ten.

Although the skilled fisherman can throw the net thirty or forty times to the hour, it must be understood that it is no easy task. It takes some time to learn how to throw the net and make it spread on dry land ; but when it comes to balancing oneself on the stern of a tiny, rocking, dug-out canoe and casting the net, the thrower would be certain to fall unless he began his lessons when a child.



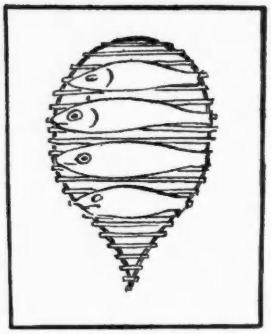
THE DIPPING NET.
This consists of cane strands or net stretched on a hinged frame, which is dipped from time to time in the river.

The fish harpoon or spear is the next most interesting form of fishing. The spear-head reminds one of a French army bayonet, though it is only fashioned by the local blacksmith out of a bar of trade iron. It is long, thin and pointed, and the more elaborate patterns have barbs. The head is fitted on to a wooden shaft about ten feet long. The fisherman stands in his canoe, which is propelled along by a companion. Owing to the muddy nature of the stream the fish are not usually visible, so the canoe follows the bank and the spearman keeps prodding the ground below the surface of the water in the hope of hitting a fish—he is often lucky.



HAND FISHING BASKET.

The women and children of a village will collect at the end of the year, when the smaller creeks are only ankle deep, and will catch fish in baskets. The basket is peculiar in shape and has a hole in the bottom. The fish are pursued into a corner by crowds of noisy children and the inverted baskets thrust on top of them, the hand is then inserted through the hole and the fish withdrawn. Fish caught in this way are very small, and are smoked till black and preserved a long time on little frames of cane which closely resemble ping-pong rackets.



A DRYING FRAME.

A large number of prawns and whitebait are caught on the Niger from time to time in very large dipping nets, which may either be made of strands of cane or of proper fish netting stretched on square frames of bamboo or palm midrib some ten feet by six. The frames are hinged in a primitive way and made to dip into the water and rise again pretty frequently. The youngest member of the family is usually put in charge, and little Chuku or his sister Ada will sit from dawn till dusk or through the long hours of moonlight dipping and raising the net by means of a string passed over a primitive pulley.

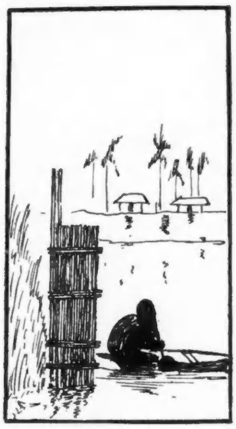
The ordinary manufactured fish-hook is now as common on the Niger as in England, and may be found in all shapes and sizes, but the types of bait used are different, and fly-fishing is unknown. The young children will start fishing with a stick, piece of string and a fish-hook baited with worms, grubs, grasshoppers, offal, etc. The child will sit astride his tiny dug-out canoe and will remain balanced for hours, as silent as a statue, in a position which civilized man could not maintain for a minute. As each tiny fish is secured he slips it off the hook into the canoe, and at the end of the day he puts his canoe on top of his head and carries it home, balancing it as easily and surely as he balanced it in the water.

The child, however, is usually not dependent upon what he catches in the canoe—he has many little rods and lines up and down the river bank. The ends of the shafts of these are inserted well into the ground and the hook drawn down into the water and secured to a sort of primitive hair-trigger, which is released when the fish nibbles the bait. This form of trap,

THE TRIGGER METHOD.

though attractive and simple, does not seem very successful, as one sees a great number of them which have been released, and their hooks hang empty with the bait bitten off. Off the trade routes, long lines supported by floats will be set across a river ; as many as thirty or forty hooks are on these, and the owner inspects them from time to time. Others prefer to use a net instead of hooks.

Where conditions are suitable large vertical traps are built, with a sliding door which drops like the knife of a guillotine directly the fish gets inside. Palm midrib, which is straight and smooth, is the favourite material for these traps, and the pieces are thrust vertically into the bed of the river so as to form a tube of square cross section. The shape is preserved by horizontal pieces bound with fibre. For catching larger fish a trumpet-shaped trap made of cane is often used—the mesh is very wide, and the cone is about the size and shape of a large phonograph horn. The point is secured by a cord which is attached to a root of a tree, and the trap floats just below the surface with its mouth down stream. The fish swim up into it and become jammed by their scales, and the more they struggle the more firmly they become fixed.



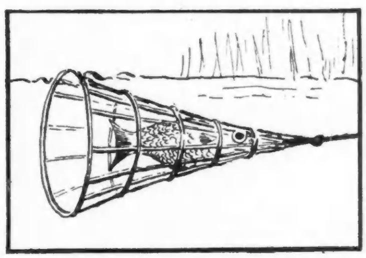
GUILLOTINE TRAP.

When waterways and rivers are being cleared of snags by the Marine Department there are huge catches. The snags usually consist of huge trees which have fallen into the stream owing to the erosion of the bank, and have become embedded in the mud. These are favourite resting places for fish. The only effective way of clearing the snags is by blowing them up.

The naked diver, unprotected in any way, plunges beneath the surface holding in his hand a charge of explosive attached to a long black fuse. He secures it under the snag with cord, sometimes remaining as much as two minutes under the surface. When the explosion takes place pieces of timber fly into the air, and quantities of fish are stunned and come to the surface where they are easily picked up by the canoes.

Of all the ways of killing or catching fish the casting net is by far the most pretty to watch. The action of the thrower is very graceful, and reminds one of a golfer playing a hard shot or of any other form of sport in which a maximum concentration of mind and energy is called for at one particular moment, and in which all muscles are brought into play within a short space of time. The surroundings will usually be tall trees, heavy undergrowth, and calm water with patches of water lilies, whilst gaily coloured kingfishers and other water fowl dart here and there and picturesque canoes of every size pass up and down.

That primitive craft, the dug-out canoe, plays such an important part in the fishing industry of Nigeria that in conclusion a few words may be devoted to it. In the first place it is just twice the width of the tree from which it is made, though this sounds impossible till one understands the method of construction. The canoe maker selects a good straight portion of the trunk and severs it from the rest. He then cuts a narrow channel nearly the length of this, which he proceeds to deepen and widen till he has completely hollowed out the interior. He then has a long hollow cylinder closed in at both ends. He now inserts wedges in the middle of the channel and by means of these he gradually widens the beam till the cylinder assumes the shape of a long narrow boat twice as wide as the tree from which it has been made. The canoe is usually made from a living tree, and the sap is dried out by the application of fire both inside and out till the surface is thoroughly charred, and the ends are sloped to form an inclined bow and stern. Thwarts are then fixed and the canoe is ready for use. A large canoe may be as much as sixty feet long and will hold many tons of merchandise. Typical examples may be seen carrying as many as twelve puncheons (160 gallon casks) of palm oil down to the river mouths and returning with great loads of Manchester cloth for sale. The smallest canoes are used by the children for fishing. The paddles are the shape of large spears.



CAUGHT IN THE CONE TRAP.
The fish swimming up stream enters the trap and the more it struggles the more it becomes jammed.

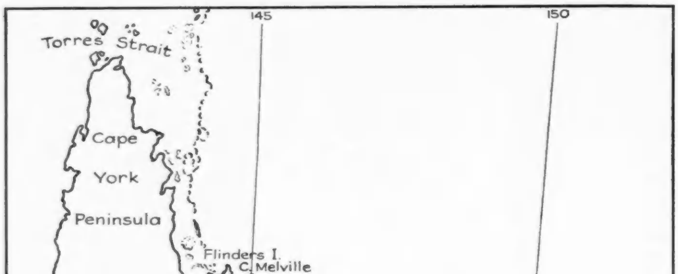
The Barrier Reef Expedition.

By J. A. Steers, M.A.

University Lecturer in Geography, Cambridge.

The British expedition to the Great Barrier Reefs of Australia concluded its investigations in July last, and has now returned to England. The geography of the reefs is here described by Mr. Steers, while another member of the party will deal with the biological work in a second article.

THE coast of Queensland is fringed by coral reefs for a distance of nearly 1,200 miles, from Torres Straits in the north to Lady Elliott Island in the south. These reefs do not form a continuous barrier, but are in patches and lines. Sometimes wide and navigable channels separate the reefs, and it has been suggested that such channels mark former river valleys, but no direct connexion is clear between the existing Queensland rivers and these openings. The distance of the Barrier Reefs from the shore varies a good deal. Near Cape Melville the inner edge is only about seven miles distant; in the south the lagoon enclosed between the reefs and the mainland may be eighty or more miles wide. North of Cairns the Barrier forms a more continuous line, and fully deserves its name; here its average distance from the mainland is twenty to thirty miles. Hence, taken as a whole, the enclosed lagoon is really a considerable sea, and, even if the big Pacific swell does not penetrate into it, there are often large waves in the lagoon. This is helped by the fact that the general trend of the coast, reefs, and lagoon is rather to the west of north, and so roughly parallel to the direction of the South-East Trades, which are the prevalent winds on this coast. The depth of the lagoon is fairly uniform, varying from ten to twenty-five fathoms. Only occasionally are greater depths found, and these are usually in association with islands and straits. In the Whitsunday Passage some soundings reach fifty fathoms.



MAP OF THE GREAT BARRIER REEFS.

There are many points of scientific interest connected with coral reefs, but it may not be unfair to say that they are divided between two big groups—the biological (to be dealt with in another article), and the geographical or geological, with which we are here concerned.

During the summers of 1928 and 1929 a party of British scientists has been investigating some of the biological problems of this greatest of all coral reefs. A small geographical party was also attached, and in 1928 cruised in a small boat, the *Tivoli* of Townsville, over much of the reef waters. The cruise extended from the Whitsunday Islands, near Bowen, to the Flinders Islands north of Cape

A MANGROVE SWAMP.
Part of the mangrove swamp on Low Isles. The headquarters of the expedition was located on the Sand Cay Islet, Low Isles.

Melville. In addition, the writer made a voyage in the Commonwealth Lighthouse Service ship, the *Cape Leeuwin*, from Brisbane to Mackay, and in this way saw something of the southern end of the reefs, including the Bunker and Capricorn Islands.

From a geographical point of view, the actual reefs do not lend themselves very much to a study of their origin. The mainland coast and the numerous islands between the reefs and the Queensland coast are of much greater importance. The mainland coast itself is a typically drowned coast ; there are many drowned valleys, now often partly or wholly silted up. The coast is steep-to, and in many parts takes on the nature of a faulted coast. This is best seen between Townsville and Cape Melville. If a study is made of the mainland, one is struck by the fact that many of the rivers, the mountain ranges, the known fault lines, etc., all run between north and north-west. This is parallel to the general trend of the coast itself, and also to the reefs. The lines of high rocky islands in the lagoon, and also some of the deeper channels in it (*e.g.*, the Capricorn Channel in the south), also show this same trend.

The mainland is for the most part composed of granites and ancient rocks, but newer rocks occur in many of the low-lying pockets along the coast, *e.g.*, near Townsville. The high islands are composed of rocks similar to those of the adjacent continent. We need have little doubt that these islands have been separated from the mainland by drowning, but in what manner did the drowning take place? The evidence is rather confusing, but, on the whole, suggests that faulting more or less parallel to the present coast is the main factor.

Nearly all observers who have visited the Barrier Reefs have invoked submergence to explain them, and it is not by any means a new view that the subsidence is due to faulting, but less stress has been laid upon this side of the matter in English scientific writings. Many Australian geologists, especially Sir Edgeworth David, E. C. Andrews, H. C. Richards and W. H. Bryan have all commented on it. Naturally evidence for such a view must be sought on the mainland rather than in the reef area proper, but the writer saw many coastal features which all go to support it. If this view is correct we must assume the reefs grew up on a faulted and submerged block or blocks, and that reef-upgrowth went on concurrently with this subsidence. It is also probable that after the faulting, which took place in late Tertiary times, there was a further submergence of about 200 feet.

If, now, we turn to the high islands within the lagoon, we find other evidence in favour of submergence. In a general way it is true to say that these islands, which may rise to considerable heights (Hinchinbrook Island, the highest, reaches 3,600 feet), are not cliffed. Cliffs are the direct outcome of marine erosion, so that if there is an absence of cliffs, we must seek a protective cause. This is found in

ON ARLINGTON REEF.
General view showing some coral growths, and the flatness of the reef. This photograph was taken at low water spring tides.

GENERAL VIEW OF THE NORTH SHORE OF COOK HARBOUR.
This type of scenery is fairly typical of much of the mainland coast north of Cooktown. As the map on another page indicates, this is situated towards the north of the Barrier Reefs.

the reefs themselves. If, as we have assumed, the reefs grew up on subsiding fault blocks, the former hills and eminences which were gradually brought below sea-level, would be protected by the reefs and so would not show any marked cliffs. Whilst, however, cliffs are not prominent features, they are not quite absent. This may be explained by the fact that the lagoon is of considerable width, and, as noted above, is not characterized by calm water during the season of the Trade winds. What cliffs there are could quite easily be formed by the lagoon waves wearing away the hard and resistant rocks of the islands.

Picturesque Islands.

These islands are very picturesque. Often they are in lines, and narrow and intricate channels separate them. These features are seen best in the Whitsunday group which extends from near Mackay to Bowen. Some of these islands reach elevations of a thousand feet, usually they are well forested, and the trees extend from practically high tide level right up to the summits. These islands are, in fact, submerged mountain chains, and in many cases are partly or wholly surrounded by small fringing reefs, which are quite distinct from the Barrier Reefs proper. These fringing reefs, too, help to protect the islands from any serious marine erosion. Further north, beyond Cape Melville, the islands and mainland are formed of sandstones, and the whole aspect is much more barren. Trees are scarcer, forests are absent, at any rate from the exposed sides, and the general appearance is wilder and less pleasing. The most magnificent of the high islands is Hinchinbrook, about halfway between Townsville and Cairns. This is mainly composed of granite and is separated from the mainland by a narrow and rather deep channel, now less wide than formerly on account of the growth of mangrove flats on its sides. The scenery of this island is truly mountainous, great crags and precipices facing the seaward side. Not far from Hinchinbrook are the Family Islands, which are small and rounded domes of granite, densely forested. They do not rise more than 100 feet or so from the sea, but seen from Dunk Island they afford one of the finest views in the Barrier waters. To describe any more of these islands would be supererogatory; a glance at the admiralty charts will show their numbers and extent better than written description.

Apart from the high islands, however, there is another class which is often more interesting. These are the sand cays and low-wooded islands. Before describing them, it is relevant to say that north of Cairns there are many patches of reefs inside the Barrier proper. These patches are scattered and much less continuous than the outer reefs of the Barrier, but it is not overstating the case to say that we have here an inner line of reefs. The low-wooded islands seem to be mainly characteristic of these inner reefs, and the simple sand cays of the outer reefs, though there are exceptions.

A simple sand cay is only a flattened heap of coral sand piled up on the lee side of a reef patch. There is no essential difference between it and a sandbank awash at low water. The life of such a cay must be very chequered; it is at the mercy of the waves, and can easily be washed away in a storm. Some of them are known to move forward bodily in rough weather. The sand of which they are made comes

from the reef patch on which they stand, and is formed by wave abrasion. This sand, in most cases, appears to be washed over the reef into the lagoon, but in others it may remain on the lee side of a reef patch and accumulate sufficiently to form a small island. Often, from one of these cays, the waves can be seen to wash round the patch of reef and meet again on the lee side. It is not unreasonable to conclude that the sand worn away from the weather side of the reef is carried to leeward, and, if the shape of the reef and other circumstances are favourable, the waves, by washing right round the reef patch may prevent all of the sand from entering the lagoon, and so cause a small sandbank to form. In course of time this bank may be built up by the waves above high water, and thus a cay is formed. Cays are small structures, usually not much more than two or three hundred yards in length, and they stand but a few feet above the level of high water spring tides. Sooner or later seeds are carried to them and plants and trees begin to grow. All stages of vegetation are to be found on them ; in one case we found seven small seedlings, none larger than a finger ; in other cases the trees are large and well-developed, and then these cays, *e.g.*, Green Island near Cairns, are very beautiful. Many are covered with creeping plants and low shrubby bushes, which are nearly always haunts of numerous sea-birds.

The low-wooded islands are rather more complex structures, and as a rule occur on the inner patches

A CORAL FORMATION.
Uplifted platform of coral conglomerate, Middle Island (near Baren). Gloucester Island is seen in the background.

WHITSUNDAY ISLAND.
A typical view in the Whitsunday Group. Cid Harbour is just beyond the low neck. Note the characteristic vegetation.

of reef. Low Islands, near Port Douglas, which were the headquarters of the main party of the Expedition, are examples. In a typical case there are really two islands, a sand cay in every way similar to those just described, and a mangrove-shingle cay, the latter consisting of several coral shingle ridges often with many complex curved ends. These ridges may often be built up high enough to form " permanent " dry land. Just within these ridges is a mangrove swamp, a dark and gloomy region. The mangrove-shingle cay occurs on the windward or exposed side of an inner reef patch ; the sand cay associated with it is on the lee side. Between them is the shallow water area of the patch of reef, which forms the pseudo-lagoon. It is a very different thing from the lagoon of a true atoll ; it is in no way to be connected with subsidence, and the two islands associated with it are wholly due to the accumulation of material by wave action. If the reef patch is small, the mangrove island may coalesce, and become one, with the sand cay, but even in such a case the essential structure is the same, the mangrove cay being to windward of the sand cay, and each characterized by distinct types of vegetation. These islands must be very unstable in the geological sense ; they are easily remoulded by the waves, and the natural tendency is for the mangrove-shingle cay to be pushed back, very slowly, on to the sand cay. Hence this is another method by which the coalescence of the two may occur. It is not unreasonable to assume that the

sand cay of a low-wooded island was formed before the mangrove-shingle cay.

Cays are often surrounded by beach rock, which is due to the cementation of ordinary coral sand by carbonate of lime. The slabs of beach rock usually dip with the slope of the beach, and naturally tend to stabilize the cay. Sometimes, however, changes have taken place and the beach rock is found dipping in varying directions. Similarly the shingle of the mangrove islands often becomes cemented, and thus forms a very rough pavement.

Although the Barrier region shows much evidence for submergence, there has been, comparatively recently in a geological sense, a slight upward movement, in two stages, of the land relative to the sea. On many parts of the mainland and on the islands are found platforms of marine erosion which are now above abrasion level. The lower of these is nearly flush with high water neap tides ; the higher, and less well marked, is about eight feet above this. It is generally assumed that the lower platform was cut when the land stood about fifteen to eighteen feet below its present level. Evidence for this same uplift is also found in some of the low-wooded islands. The beach rock and conglomerate surrounding these islands are often now above the level at which they normally form, and the sea is cutting into them. Other evidence for recent uplift is probably to be found in the extensive mangrove flats of parts of the mainland and high islands.

Coral Gardens.

So far little has been said of the reefs. Unless expensive borings are put down, as has been attempted on Michaelmas Cay, they tell little of their origin. Their problems are biological. A reef flat is a rather dull and dreary place. The surface is practically level, and of a dull brown colour. Some living coral is found in pools and fish and other creatures are often trapped at low water. But the edges of a reef are very different. Here, in the deeper water are the "coral gardens" resplendent with colour and life. Great masses of coral of all shapes are seen, and highly coloured fish are common, but it is not always easy to examine such places at leisure. The windward side of a reef is a very dangerous place, and is safe only in very exceptional circumstances. There are similar pools on the lee side of reefs, and a diving helmet has to be used for observing their wonders. Some of these will doubtless be described in the biological article to follow in a later issue.

The "Next Step."—XII.

Some Possibilities in Engineering.

By William Kerr, Ph.D., M.I.Mech.E.

Associate Professor of Engineering, Glasgow University.

In our concluding article on some Next Steps in Science, Professor Kerr predicts that the course of engineering will be determined by systematic investigation rather than fortuitous invention. There are many possibilities, but in every branch of this wide subject the ultimate issues are dependent upon progress in mechanical power.

Modern civilization relies absolutely upon engineering as its chief servant. The material welfare of mankind and the industrial prosperity of nations are dependent upon its attentions and attainments. Many of the faults, and most of the benefits of modern life may be charged to it—the national problems of unemployment, to some extent, and the municipal problems of traffic congestion, fully ; the equipment for war, deplorably, and for work, efficiently ; and the spaciousness and material luxuries of life, agreeably. All these, and many other characteristic features of existence to-day, may be claimed—joyously or otherwise—as the consequences of engineering developments. Indeed the history of the past century simply reflects a forward propulsion, literally and figuratively, by mechanical agencies. In some quarters this is considered regrettable ; but in no quarter can it be denied.

The ramifications and activities of modern engineering are so vast that no short article could hope even to enumerate the details. But all branches of it are, in their ultimate or primary issues, dependent upon mechanical power. Whether we think of the marvels of electrical engineering ; the spectacular structures or extensive geographical projects of civil engineering ; the altogether surprising developments of transport by land, sea or air ; the extensive plant of steel works, coal mines or shipyards ; or the special and intricate machinery of innumerable industrial factories ; in the end we come to the questions of the provision and problems of mechanical power. In so far as it is permissible to view the characteristics and possibilities of engineering by consideration of a

main and dominant activity that prospect and chance are provided by what is known as power engineering. It has become a habit with statisticians to measure industrial values and advances by means of the mechanical power per unit of population. While this gives rise, at times, to slightly misleading conclusions—notably in cases of smaller countries of recent industrial development along special directions—the line of thought is legitimate, and the importance placed upon mechanical power is significant and correct. Any general consideration of engineering possibilities could not, for any conceivable purpose, ignore the power aspect; and in most cases consideration of the power problem is wholly adequate to the purpose.

Past and Present.

Until about the beginning of the present century nearly all mechanical power was derived from steam engines. The central power station on land; the railway locomotive; marine propulsion; and factory plants, were all dependent upon the simple reciprocating steam engine, whose general principle was established by the genius of Watt, and applied to a multitude of purposes by innumerable followers. The mechanical age had developed steadily and surely under the régime of the steam engine. That it had developed to any extraordinary degree of efficiency could hardly be claimed since, even twenty-five years ago, the proportion of the heat energy in the coal transformed into mechanical work by the engine was about ten per cent—hardly ever more, and very frequently less. The simple boiler-engine-condenser system had reached a stable state of minor efficiency, but great reliability; and general engineering had very much the same characteristics.

Practically within the period of one generation all this has been changed. In the immensity of power totals; the outputs per machine; the new forms; the variety and manifold applications of the methods of development; and in the great increase in efficiency of working, the contrast between the end of a quarter century and its beginning is truly amazing. The advance has been feverish at times, not wholly unmarked by disaster, but certainly not devoid of triumph.

The steam turbine has completely displaced the reciprocating engine for all main purposes on land, and has grown rapidly to a dominant position as the only type of power unit that can satisfy the incessant and ever growing demand for electrical energy. It is also the only power engine offering that large capacity per unit required for the propulsion of large fast merchant ships and for naval vessels. It has, in reality, created the modern super power station and the "super" ocean liner. Its advance has not been in gross power only. Its efficiency has been steadily improved by a growing knowledge and technique of construction; and, especially in recent years, by striking developments in steam boiler practice and refinements of design. High steam pressures of the order of 400 to 600 lb. per square inch, and steam temperatures of 750 to 800 degrees Fahrenheit are now in use; and, in contrast with the ten per cent maximum thermal efficiency of twenty-five years ago, the modern boiler-turbine-condenser system can show about twenty-five per cent.

At one time—and even within the past decade—the utilization of natural water power resources was thought to be a possible and cheap method of keeping abreast of the growing modern demands. It is now obvious that, even in the most favoured countries, this is impossible. America has already developed one third of her total resources in this respect, but this is less than one quarter of the present demand for power; and the growth exceeds vastly the possible rate of exploitation of the remaining water power. The developments in this line have, however, been a feature of recent years. Cheap power was, at first, the popular expectation, but it has come to be realized that the true function of the water power scheme is as the complement, and not the competitor, of the steam plant. Alternatively, as in the Scottish Highlands and elsewhere, it can create new centres of industry.

The Diesel Engine.

In parallel with the power systems mentioned, the internal combustion engine has been developing in a highly remarkable fashion. In its practical forms to-day it exists mainly as a reciprocating engine type; but it is very successful as that. The light petrol types have, of course, made the automobile and aeroplane possible. For land power applications the engine appears in many forms, and is used for many purposes. Its outstanding advantage is high thermal efficiency, and in this respect it leads the steam system; although the superiority is, of course, modified when translated into terms of costs. The Diesel type of engine is meeting with a partial success in railway traction; but its main triumph is in the marine field. Its widespread success in the cargo and intermediate classes of merchant vessels must be recognized as one of the engineering surprises of recent years. The intensive development of the engine for this line of application has been mainly prompted by the promise of fuel economy and reduced running charges, coupled

with the elimination of the boiler room, less fuel weight carried and increased cargo capacity. Its success in marine applications, wherein reliability has always been a supreme requirement, is evidence rather of a high engineering technique than of inherent simplicity in the engine. It is not simple, but it is certainly successful.

This brief review of the situation is quite inadequate to indicate the complexities that surround each type or each application; but it may serve to establish certain salient facts. We may now consider some of those matters and aspects that provide indications or explanations of future developments.

Future of the Turbine.

The modern steam turbine has reached such efficiences that little more can be hoped for except by the increase and intensification of the operating conditions. The present thermal efficiency limit of around twenty-five per cent is an excellent performance, only to be reached by first-class plants utilizing pressures about 600 lb. per square inch, and temperature of about 800 degrees Fahrenheit. They must also employ special processes known as "bleeding," in which working steam is abstracted at places to heat the feed water; and "reheating," in which the steam at one place is returned to the boilers to have its lost heat restored. Further exploitation of these already severe conditions can only proceed within certain limits. Temperature increases rapidly discover the weaknesses of engineering materials. In spite of steady advances in the quality of steels and alloys, there is as yet no reason to expect the very early arrival of an outstanding material able to exist for long without serious "ageing" in a very high temperature steam atmosphere. There is scope for a fairly general advance in pressures, although the highest that would appear advantageous has already been tried in one or two cases. As a combined advance, a pressure of about 1,200 lb. per sq. inch, in conjunction with a temperature of about 900 degrees Fahrenheit, seems the ultimate limit that need be attempted. At these values, with the full use and considerable development of all the special refinements of the modern steam cycle, it is possible to reach a thermal efficiency in the pure steam plant of around thirty-six per cent. This provides a notable margin of improvement well worthy of the effort of attainment.

But additional prospects are open to the turbine by the adoption of other fluids in conjunction with the steam. The total temperature drop will always be decided by the limitations of materials. But we can imagine this drop being covered by two different fluids in sequence, each with fair pressure drop corresponding to its share of the temperature change. Thus mercury vapour and such compounds as diphenyl-oxide are being investigated as possible media for the first step of this "binary," or double fluid scheme. The heat of the fuels would be used to boil, say, mercury. This would then work in a special turbine, the condenser for which becomes really a steam boiler. The steam thus formed takes up the work duty, and passes through its own turbine in the usual way. The difficulties of such processes are enormous. They have been under investigation for some time, but results are not yet fully conclusive. The system, if fully successful, would promise thermal efficiencies equal to, or greater than, the Diesel engine; with, of course, all the advantages of turbine types for high power in addition. But the system as one of possible general application belongs to the more remote future.

Boiler Tendencies.

The more advanced established practice of the moment in boiler operation involves very large boiler units approaching a self contained single boiler single turbine system, burning pulverized fuel in large furnaces, almost surrounded by water tube walls, operating at the pressures and superheats required by the turbine, and reaching in steady performance the remarkable efficiency of about ninety per cent. A recollection of the usual sixty per cent of not very many years ago emphasizes this improvement. Every step possible is taken to conserve heat; and the heat in the outgoing gases is employed to heat the combustion air passing in to the furnaces. Little more is to be expected from the present system, except by the more general adoption of its methods, refinements and precautions. There are some difficulties regarding chimney gases, combustion, and materials, which, however, can hardly be considered insurmountable; and this advanced practice of the present will surely become quite general in the immediate future.

Beyond this, however, quite new methods of steam generation are being tried, and in their present or modified forms may constitute the practice of the future. The extraordinary Benson boiler overcomes completely the problems of ebullition in the water tubes by generating steam at the critical condition, whereat the water is changed to steam without change of volume. This means a generating pressure of 3,200 lbs. per square inch; and the steam has to be reduced before passing to the turbines. The scheme is absolutely new, rather remarkable, and presents

grave constructional difficulties; but it is by no means impossible, although very extensive trial will be necessary before its prospects as the boiler system of even the more remote future can be properly assessed. Another new system of Continental origin has also reached the trial stage on a fairly large scale of recent years. This is the Löffer scheme, which again provides a fundamental change from standard practice. In this, the furnace heat is employed to produce steam at high pressure and temperature, and this steam is passed directly into water in a simple drum, from which the turbine draws its supply. The arrangement has been adapted both to land power units of fair size and to locomotives, and its possibilities of survival should shortly be clear. These special types indicate the tendencies. The long established forms with their modern perfections are reaching a limit; and, while further improvements in efficiency are unlikely, either from old or new types, the questions of space reduction and greater evaporation rates demand fundamental changes in the process.

The Waste Heat Problem.

The condenser of a steam plant has simply to condense the steam after working. But to do this enormous quantities of water are required. The heat carried away by this water is truly enormous. It may be several times the value of the real work done by the turbine. It is not merely wasted; but large and costly plant is necessary to waste it. It is this item of loss that renders the heat efficiency of a power plant low. Because of this the coal and water requirements of the super power station are stupendous. It requires, in fact, a coal field on the one side and a river on the other, and in inland cities the water difficulty is indeed acute. The best use of the discharged heat of power plants is made in factories using steam for industrial heating or process work. There the steam for heating is the main function, and the power generated from it before it is so used is a "by-product." In the large power plant, however, the steam is discharged at low temperature, but in enormous quantities. It is a waste product. Its recovery and use represents an outstanding problem in industrial economics. Many suggestions have been made, and a few tried. In one Canadian plant the city water supply is passed through the condensers during the cold months of the year, and the waste heat maintains a temperature that enables the filtration plant to be kept in operation. In other cases the power plant serves as a central heating system, and furnishes heat to surrounding buildings; while again the interesting suggestion has been made to pass the condensing water through underground pipes in aid of vegetable culture. The waste is clearly realized. There is no lack of suggestions, but the costs and reorganization required appear prohibitive. Nevertheless it would seem that very serios attention must be directed in the future to the matter of this enormous and continuous wastage of heat.

Internal-Combustion Systems.

The Diesel engine has advanced steadily, but is approaching definitely its limits of output. Already enormous in dimensions, the output of the single unit is in no sense comparable with the turbine type. Centralization of power in land work is, therefore, not possible with it. Its relatively high efficiency has led to the suggestion, however, that decentralization would really be an advantage! Nevertheless, it is clear that the piston type of internal combustion engine will hardly compete in large scale land practice. Its main and natural applications lie in marine and locomotive work. In the former line it has practically achieved its end; in the latter it has still great scope and very considerable prospects.

The steam turbine has followed the reciprocating steam engine; and naturally a gas turbine might be expected to follow and advance from the limits of the gas or oil engine. The road seems clear; and many attempts have been made to travel it in recent years. Actual progress is not great, however, for the path is full of pitfalls. The gas turbine has to use the products of combustion directly. Steam at 800 degrees Fahrenheit makes serious demands on the materials used in steam turbine work. The difficulties are clearly much greater in the gas turbine, where the temperatures are so much higher. The main practical solution so far attempted involves the employment of a repetitive action of the turbine jets so that a cooling interval follows the high temperature period. This allows mean temperatures of the reasonable order of 1,000 degrees to be attained. The gas turbine at present has a thermal efficiency about equal to the steam boiler-turbine-condenser system; but in reliability it is much inferior. The ultimate solution of the difficulties surrounding it is by no means impossible; and it is a probably important power type of the not too distant future. It is well to realize, however, that its successful development depends less upon fortuitous invention than upon the provision of all the resources of systematic investigation and the progress of metallurgy. The same could, perhaps, be said of all the probable lines of development with which the engineer is confronted.

By River to Roumania.

By J. E. Pryde-Hughes, F.R.A.I.

A recent journey down the Danube, from Budapest into Roumania, gave the writer some interesting sidelights on the country and its people. Apart from commercial possibilities, Roumania offers scope to the archaeologist.

THOUGH the old-world atmosphere of Budapest belongs to another age, it is after leaving this bright and pleasant capital that the sense of the past surges up most strongly. The broad river carries the traveller into the heart of the plains, and bleak-looking hills stand a little off the banks on the right, where well-to-do peasants of Swabian descent farm and cultivate the grape for wine. At one small village town a mighty fellow, over six foot tall and proportionately broad, initiated me with some of his friends into the mysteries of the wine cellars—great caves scooped out in the hillsides where I was told that Christians worshipped in secrecy during the Turkish occupation. A greater mystery was how I managed to stand up to the initiation rites so well! At each great *tonneau* the master of ceremonies dipped in a long glass tube, which had a large bulb near the upper end. Both ends of the tube were open, and placing his mouth over the upper aperture, the operator sucked up wine into the bulb. When this was full he withdrew the tube and quickly slipped his finger over the lower hole, then filled each glass by simply removing his finger until a sufficient supply had flowed out.

The river now travels through rolling cultivated plains to Mohacs. Here the vessel coaled, and women and men—the latter stripped to the waist and in shorts—wheeled barrow loads of small dusty coal up a narrow plank. It was on the plains of Mohacs in 1526 that the Turks delivered the knock-out blow to the Magyar champions after a very meritorious resistance. The flower of Magyar chivalry went down in this terrible conflict and the Islamic forces spread all over the land.

The wide stream here seems to roll on more slowly and stately through meadowlands and moors, which are divided by hundreds of arms and inlets and by marshy stretches where game abounds. Hungary is left behind and Yugo-Slavian territory lies on both banks. The Drave comes in on the right; in the growing dusk the solitariness is impressive, though hamlets and townships appear at regular intervals, and after the Tisza joins its parent river near Slankamen, the lights of Belgrade appear in view. Below the capital of Yugo-Slavia the Serbian mountains follow the stream, though the left bank is still flat. The Save flows in at Belgrade and for some while the channel is obstructed by rocks, the river passing through a series of gorges for sixty miles between the Carpathian mountains and the Serbian Highlands. The landscape is wild and romantic.

At Golubac, with its ruined fortress, the stream enters the narrows with the rugged Babakai Rocks standing out like sentinels. Down to Dobra the limestone walls are hollowed out with numerous caverns, and then the steep banks and rocky shoals consist chiefly of crystalline schists and granite. The lofty grey hills narrow the river down to a thin, rapidly flowing ribbon, and with tremendous power the waters are forced through the giant Goeben defile, where Roman pioneers succeeded in constructing a road despite the enormous difficulties. The Goeben defile begins at Drenkova, to be followed by the rapids of Izlas, the Upper or Lesser Iron Gates (Gornje Demir Kapu), sometimes confounded with the actual Iron Gates below Orsova. Beyond lies the most beautiful stretch of the river—the magnificent Kazan Narrows, or Lower Klisura. Towering crags rise up on either side, some bare and

MOSQUE AT CONSTANTZA, BLACK SEA.

PICTURESQUE RIVER MILLS OFF THE ROUMANIAN SHORE.

The flow of the current operates the giant paddle wheels, which in turn grind corn. These primitive but effective mills are constructed on barges.

rugged, others beautifully clothed with trees. A majestic sight—closing in at sudden bends of the stream, then receding a while only to close in again lower down, it remains the most impressive memory of a journey on the Danube, more impressive than the famous "Iron Gates" below Orsova.

Orsova, a flourishing Roumanian town, is immediately followed by the romantic Ada Kaleb Island. As one lies off the island waiting for the distant signal ball to fall and so announce that the navigation channel of the Iron Gates is clear, the mosque and the typically Turkish character of the island with its Moslem inhabitants become apparent. The ball falls, and the vessel cautiously slips down to the mighty cataract of the Iron Gates. Cruel rocky ledges jut out into the stream for about a mile, forming a dangerous barrier on which in days gone by many a vessel met its doom. Even as we passed we saw the bare ribs of an unlucky ship which had been caught and wrecked on these rocks. Until 1846, when steam navigation was introduced, few vessels ventured to pass the Iron Gates, and even then only smaller vessels between the months of March and November. In 1890 a channel for navigation was started. It is a protected canal about ten feet deep, safe for navigation but through which the water rushes at a terrible speed. A short stretch of railway line runs alongside with an engine to help upstream vessels make their way through against the powerful current.

It is supposed that the Iron Gates were once closed and that the river burst through. This may be so, if, as some believe, the Alföld (in Hungary) down to Belgrade was once a great but shallow inland sea, the overflow from which gradually ate its way through the gorge. At any rate, the gorge is still deepening.

A rise of thirteen feet in the level of the Danube causes the waters of the Tisza to flow back as far as Szeged, where a disastrous flood occurred in 1879. The alpine snows are chiefly responsible, with the early summer rains, for a rise of the waters which cannot get away through the gorge fast enough. The level of the river therefore has to be carefully watched to prevent floods which may bring ruin to the countryside Beyond the Iron Gates the chain of hills recedes, and by the time the river reaches Turnu Severin, an important Roumanian station, where the Emperor Trajan erected a great pillar bridge over the stream, the banks on both sides wear a much more peaceful aspect. In parts the Danube is now two miles across and flows placidly to the sea, taking a turn north at Cernavoda.

I left the river at Giurgiu, the Roumanian port opposite Russe (Rutschuk), the important town on the Bulgarian coast. At Giurgiu traces of the war's destructive work were still visible. After a miserable wait of a couple of hours while the officials scribbled every word on the passports of passengers into a book, I ignored the train, as advised, and took a taxi for the two hours' road trip to Bucarest. For all the bumping, sliding and dust, the ride was worth while. All along the roadside stray cars and taxis were stranded, while either petrol was requisitioned from other cars or repairs were made. We had not been on our way fifteen minutes when we were held up by a prancing figure who, when we stopped, went straight to the petrol tank and drew off a pint without any protest being raised! My own car fared well, but I noticed a pleasant camaraderie amongst these drivers of ramshackled automobiles, and only my urgency prevented a stop to help every lame duck.

Half way along, choked with dust, we halted in a tiny village for refreshment. It was a queer make-do place carried on by a kindly young fellow and smiling wife who served me with wine and "splash" (a siphon), and some fresh tomatoes. The driver at my invitation drank some non-alcoholic coloured concoction which would have been a great delight to the eyes of a London street urchin! With a lot of talk, the sense of which I mostly guessed at, sometimes correctly, we raced on to Bucarest and a bath, to wash off large quantities of the dusty plain accumulated all over the body, for the dust penetrated summer clothing easily. The smiling driver accepted the agreed fare with thanks—to my surprise, for strangers had led me to understand that these Giurgiu-Bucarest taximen were pirates and worse.

Wolves and Bears.

Due east from the Roumanian capital the river is picked up again at Cernovoda, beyond which is the growing port of Constantza on the Black Sea. Flowing through the Baragan Steppes past Dobrudja, it comes to Braila and Galatz, the first a pretty town on the outside bend of the broad stream, and fast overtaking in importance the older town with its extensive grain and other depots. Between the foothills of the Carpathians and the Dniester is the Moldavian plateau and Bessarabia, through which the Pruth and Sereth flow to join the Danube near Galatz. From Cernovoda north, and beyond Galatz, going east to the delta, vast marshes exist—broad expanses of reeds, willows and tamarisk, through which are numberless channels connected with the river. This is the home of pelicans and coots, herons, storks, wild duck, geese and plover. Wild boar live in the forests with wolves and occasional bear—a truly wild, sometimes savage territory. The waters teem with sarda and salmon, pike, sturgeon, etc. The delta is a splendid example of its kind, the river spreading over a large area in places and running into three channels, the Kilra, Sulina and St. George. The navigable channel is the Sulina course, which has been regulated and straightened, with the increasingly important township of Sulina at its head where the river empties into the Black Sea. As it crosses the Wallachian plains the Danube has a width sometimes of up to two miles, and vessels of 1,000 tons can be used, though vessels of more than 500 tons cannot go above the Iron Gates at low water. The plain is fertile, growing large quantities of maize and wheat, but communications are lacking.

The Roumanians are essentially a peasant folk; their land might grow food for a great part of Europe, but co-operation is needed. Improved communications—especially good roads—are urgently required all over the plain. During my stay I sensed a stirring in this direction. A great deal of new work was apparent in Bucarest, Constantza, Braila and Galatz. If the effort extends and is pushed across and up and down the plains, it must increase the effective production enormously, and instead of grain exports dwindling (as I believe has been the case in the last couple of years), Roumania may become the greatest grain and produce exporting country of Europe. The possibilities appear to be enormous. In 1929 no less than 4,798,000 hectares were under maize, and the average product was 1,330 kilograms per hectare. The total maize harvest was 638,404 waggons. In Bukovina 63,000 hectares were under maize, with an average yield of 1,480 kilograms per hectare—a total of 9,324 waggons. The 1928 figures were a total of 275,630 waggons. Of the 638,404 waggons, 360,000 were retained for home consumption, and 278,000 waggons were available for export. The total harvest of maize and other cereals for 1929 was 1,310,000 waggons, of which 525,000 waggons were available for export—a calculated export value of 27 milliard Lei (over three million pounds sterling).

Besides the commercial development of Roumania, there is scope for much research work also, for up to the present little beyond the neolithic discoveries at Cucuteni (Moldavia) have been found. Yet judged by its fertility the land must have supported people from the very earliest times, and much more evidence of these ancient inhabitants should be available.

Winter Cruises.

By way of a change from the south of France and Mediterranean, increasing numbers of winter holiday-makers are now making cruises in the South Atlantic. The following notes concern the cruises which are announced in the advertisement pages of *Discovery* this month.

It is not generally realized that in less than two months the modern traveller can visit the Caribbean Sea, with its "Islands of Sunshine"—the British West Indies. In steamers of the Harrison Line a round trip of six weeks can be made from London, visiting Barbados, Grenada, Trinidad and Georgetown, B.G. The Booth Line has introduced a winter cruise to the Amazon, sailing from Liverpool on 9th January. Hitherto this voyage has been made only between March and November, but as the climate varies very little all the year round, this extra sailing is being added to the programme. Mention has often been made in these columns of the wonders of the Amazon, but their attraction will long bear repetition, since the region surrounding this mighty river is one of the few accessible parts of the earth still relatively unexplored.

Another Atlantic cruise, but in the eastern area, is offered by the Canadian Pacific liner, "Duchess of Richmond," which, on 25th January, will leave Liverpool for a six weeks' cruise to the Isles of the Blest, West Africa.

Can Fog "Crashes" be Avoided?

The aeroplane which crashed in a fog last month on the Surrey hills has emphasized afresh the problem of fog flying. The following are extracts from a report just issued by the Guggenheim Fund for the Promotion of Aeronautics, New York. For three years intensive research has been carried out.

THE principle of successful fog flying was demonstrated in America on the morning of 24th September, 1929. Seated in a completely covered cockpit and guided entirely by his instruments, Lieutenant James Doolittle took off from Mitchel Field, flew away from the field, turned around, recrossed it, turned again and came back, landing a short distance from his starting point. The demonstration marked the consummation of a year's concentrated efforts to discover a solution of flying and landing through fog. The experiment has only established the principle of safe fog flying which must be eventually perfected for commercial use, but it points the way to the elimination of the last great hazard to the reliability of aeroplane travel.

Night Flying.

At the time that the Daniel Guggenheim Fund for the Promotion of Aeronautics was founded, flying was passing from the purely military and experimental stages and becoming in European countries a means of commercial transportation, competitive with ground and sea transport systems. It was appreciated by the Fund that in order to promote commercial aeronautics, flying must not only be a safe and rapid means of travel, but one dependable and reliable as well. Navigation at night, in snow storms or in fog, when visibility is low, was one of the outstanding unsolved problems.

Some investigations along this line had already been carried out by Governmental departments in the United States and elsewhere, studying more or less independently different phases of the problem, such as fog dissipation and wireless communication. In order to expedite and concentrate this work the Fund, in September, 1926, organized an informal committee for the coordination of fog flying research. This committee included the Assistant Secretaries of War, Navy and Commerce, representatives of the Weather Bureau and the Post Office Departments, also Mr. Harry F. Guggenheim, President of the Fund. In order to assist the enquiry and to broaden its scope, monthly reports describing the developments in Europe were sent to America by the Guggenheim Fund representatives in England, France, Holland, Italy and Germany.

The main problems to be considered were defined as follows: (1) Dissipation of fog; (2) Development of means whereby flying fields may be located from the air regardless of fog; (3) Development of instruments to show accurately the height of aeroplanes above the ground, to replace barometric instruments now in general use showing height above sea level; (4) Improvement and perfection of instruments allowing aeroplanes to fly properly in fog; (5) Penetration of fog by light rays.

In previous studies it has usually been assumed not only that the wind velocity was very low, but also that the region of poor visibility existed only at low altitude and could be surmounted by a balloon anchored on the ground. The Fund has discounted both of these assumptions; the first is obviously erroneous for flying in snow blizzards, and the second cannot be depended upon, because of existing knowledge of fogs continuous from the ground to a height of 10,000 feet.

Special Machines.

As regards aircraft equipment, the Fund examined all available ships being produced in America, and finally selected machines known as the Consolidated NY2 and the Vought O2U-1. The NY2 is admirably suited for fog flying or blind flying because of its low landing speed, its rugged construction and high factors of safety and easy access to all parts of the aeroplane for installation of special equipment. Preliminary tests showed that it could be flown into the grounds at speeds up to fifteen miles per hour above the landing speed without damage. To improve the machine further for fog flying work, the rear cockpit was equipped with a crash net about six inches from the instrument board and a new wind shield was installed to give more protection to the pilot. The craft was equipped with all practical aids to flight and navigation, including an ice warning thermometer, an earth inductor compass, besides the wireless equipment.

The "Corsair" O2U-1 fills the needs of the Fund for a ship having a greater speed than the Consolidated NY2 either for the testing of special instruments and

equipment or for cross-country missions. The first "Corsair" was badly damaged upon returning from Buffalo when fog was encountered at night and a blind landing was made near an airways' beacon in New Jersey. This flight emphasized the necessity, first, of carrying parachute flares on all night flights; second—frequent and reliable weather reports, preferably obtained by radio during flight; third—excess motor power when flying in fog; fourth—locating landing fields near airway beacons and giving them illumination by stray light from the beacon. The superiority of electric flashes from car rails as a means of fog penetration, confirmed by Colonel Lindbergh's observations, was also demonstrated.

Wireless Equipment.

The next question to be considered is the use of wireless, which is obviously one of the most important aids in blind flying and navigation. It seems reasonable to suppose that it can be extended and possibly will furnish the most effective solution of fog flying. In the present development of the art, radio is used for several purposes, as follows: to keep the pilot informed as to changes of weather along his route; to get position of the aircraft, either by means of bearing observations made in the aeroplane or on the ground; to follow a definite course as marked out by a wireless beacon; to obtain information as to landing conditions at the airport, such as, for example, the barometric pressure at the ground level; to call for aid in giving the aeroplane's position in case of an emergency landing.

One serious difficulty experienced by the Guggenheim Fund enquiry, in connexion with wireless receiving sets, is the control of sound volume. For example, in approaching a beacon station, the sound intensity changes at such a rapid rate as to take up too much of the pilot's attention in adjusting the set. This question of automatic control is one that has been given consideration and one for which a satisfactory solution will soon be obtained.

Still another difficulty associated with wireless is the proper shielding of the aircraft ignition. The Fund has found adequate shielding for the ignition wires, but so far has not tested any shielded ignition plugs which were completely satisfactory. Difficulty with plugs tested has been not so much in the absence of shielding, but in improper insulation between the shielding and the high tension wire resulting in poor operation of the motor, especially in wet weather. Complete solution of this problem seems to be one that may come about automatically through the use of the Diesel type engine.

Investigations conducted relative to choice of wireless transmitting sets for aeroplanes have pointed towards the use of a low power short range set as against more powerful equipment. This is for the following reasons: First—the weight of the transmitter increases very rapidly with its useful range. If long wave lengths are used, the set is unduly heavy. Second—radio bearings made by ground stations are likely to be erroneous under bad weather conditions. If short waves are used, the reliable range can be covered with a low powered set. The chief use of the transmitting set in fog flying seems to be in getting information as to ground conditions and in asking for wireless bearings from the ground when near the landing field. For these purposes a short wave transmitting set seems to suffice. One particular advantage in the short wave is its freedom from static interference on weak signals.

The Radio Frequency Laboratory has just constructed a light transmitter which will not require a double voltage generator on the motor to supply plate voltage. On this set the plate voltage is supplied by a Ford spark coil operated on a starting battery in the plane. The whole set which should be good for transmission up to 150 miles, weighs only four pounds. As this set operates on a short wave length and can be used with a wing antenna, it is of special interest for fog flying since it obviates the use of a trailing wire which must be drawn in before landing.

Instrument Problems.

As regards Flying Instruments—the third problem—the Guggenheim Fund has been no less active. One of their projects was the simplification of the instrument board and the procurement of a flight indicator which would be simple and more direct in its indication, and require less translation and mental effort on the part of the pilot. With the ordinary equipment, blind flying is theoretically possible so long as the aeroplane does not come in contact with anything on the ground, but in practice it has proved to be very difficult, and is possible only with a personnel particularly skilled in the use of instruments. Even with practiced personnel, flying with a turn indicator when the horizon is not visible, is very fatiguing if carried on for several hours under ideal conditions. In bumpy air it is difficult to maintain a desired course even for a few minutes and many accidents have occurred.

As a first step in simplification, the Fund's two aeroplanes were equipped with instrument boards so arranged that the hands of all directional indicators formed a straight vertical line when level and flying

straight, and the hands of all indicators affected by fore and aft inclinations formed a horizontal line when in normal fore and aft attitude. With this instrument board the pilot can detect deviations from straight and level flying by watching for irregularities in two intersecting lines. Grouping of a number of instruments in this way gives something of the effect of a single instrument combining the indicating properties of the whole group.

A Single Indicator.

The next step was the procurement of a single instrument which would replace a number of other instruments giving less direct indications. The pilot, when the visibility is good, depends almost entirely on the attitude of his aeroplane as seen against the horizon line for determining proper conditions of flight. It was believed that this instrument should take the form of an artificial horizon line mounted on the instrument board and arranged in such a way that the pilot, by looking at it, would receive the same information in manœuvring as from the horizon itself. Accordingly, the problem was taken up with certain instrument makers, and resulted in the construction by the Sperry Gyroscope Company of a device which gives a direct indication of attitude and appears from its first preliminary tests to be very satisfactory.

Instead, however, of maintaining the proper speed and attitude of the aeroplane by flight instruments when flying blind, a pilot may in theory at least depend upon the action of an automatic pilot. In addition to controlling the speed and attitude, such a device may even hold the machine at the desired altitude or on the desired inclined flight path, as well as on its proper course. But in practice the difficulty of over-control arises through the failure of this automatic pilot to reverse or even return the controls to neutral until the aeroplane has passed through the normal attitude. Because of the weight and mechanical defects in existing automatic pilots, the Fund has depended so far upon inherent stability in the aeroplane for relieving the pilot of unnecessary strain in blind flying. Both the Fund's machines are positively stable about all axes at normal speeds. There is, however, considerable improvement to be made.

The next main sections of the Guggenheim Fund's Report are devoted to direction finding in flight and also to position finding near fields and on land, but as similar research on this question has been dealt with in *Discovery*, we must pass, in conclusion, to the question of fog penetration. The report points out that there is little hope at present of finding any visual light which will penetrate a thick fog. A light source surrounded by fog may increase the illumination at points where the direction of the light source cannot be determined. If the light source is modulated, the presence of this particular light may be picked up by delicate instruments on the aeroplane. In this way, the approximate position of an aeroplane over the ground might be determined when the direction of the light could not be found. Air mail pilots, very familiar with their route, when flying at night and in snow storms, have known their position from the extent and colour of the glow which they could see beneath them. As opposed to this evidence, there are experiences of pilots who have attempted to land at airports in heavy fog and who have found that although they were sufficiently near to the airport to have their motor clearly heard on the ground, they could not see any light coming from the flood lights below them. It seems probable that lights can be depended upon only for showing the proximity to objects as by the use of flush lights on the ground to show the height of the landing surface.

As to the best colour of light to be employed, there is little choice from the point of view of penetration. Red or neon lights have the advantage of being easy to pick up in contrast with lights of other colours.

Fog Penetration.

Since the problem of fog penetration by electro-magnetic waves is of fundamental importance, Dr. Anderson, of Washington University, Seattle, has been retained by the Fund to work on this problem, assisted by Dr. Barnes of Bryn Mawr College. Up to the present time Dr. Anderson's efforts have been directed toward the construction of equipment for generating and maintaining fogs of standard density and toward the collection of equipment for making quantitative measurements. A few preliminary tests indicate that there is very little difference between the penetration qualities of different wave lengths within the visual spectrum when a really dense fog is concerned.

The next step in this activity will be a study of the infra-red and heat sprectrum involving as far as is possible all radiations between visual light and short wave radio. A study already made seems to indicate that the penetration of infra-red light is selective, and that so long as a fog of uniform size particles is concerned, very large variations in penetration are found for comparatively small changes in wave lengths. Whether or not fogs encountered in flying have particles of sufficiently uniform size to permit the use of selective penetration is yet to be studied.

The Black-Throated Diver.

By Oliver G. Pike, F.Z.S.

The black-throated diver is a purely aquatic bird, which has a cry so strange that peasants still regard it as the voice of a witch. The author travelled a thousand miles to observe and photograph this rare bird.

THE loch was set in the romantic surroundings of an island in the Outer Hebrides. Around it were steep slopes, with wild and rugged mountains beyond, and not a tree of any description in sight, not even a hedge or a bush. The pale grey mountain grass and the bare rocks lay in jumbled masses on the open moors. This seemed a strange spot to visit to study bird-life, but far out on the sun-covered waters there was a dark dot, and my field-glasses showed that this was a black-throated diver, which I had travelled nearly a thousand miles to see. It appeared to be very low on the water, and as I watched, it continually submerged itself. The bird knew it was being watched, and was behaving in this manner to escape from the observer.

Somewhere on the little islands of that loch, or on the surrounding shore, that bird had its nest, but as one gazed on the thousands of possible sites it seemed a hopeless task to discover it. On the loch itself there were nearly four hundred small grassy islands, and any one of these might contain the eggs. However, there was a small boat there and I commenced the search. Fortune favoured me that day, for after examining about forty islets, I found the two large olive-brown eggs in a slight hollow, six feet from the water, on one of the larger islands. The black-throated diver makes very little attempt at nest building; the eggs are laid in a slight scratching in the ground, but a few grasses are added as incubation proceeds. The nest is placed very near the water for the good reason that the diver has the greatest difficulty in walking on land. On the water it is a remarkably clever diver and swimmer, and in the air it would outpace most birds, but on the ground it is helpless. It has a large heavy body, and the legs are placed very far back; when it attempts to walk, the body appears to be too heavy and it falls forward on to its breast. When the bird wishes to progress on the land, it first shuffles out of the water and with great exertion stands upright. Then it falls forward, drags the feet under the breast as far as possible, stands up once more, and again tumbles down. By struggling along in this clumsy manner it is able to make slow headway.

THE DIVER'S EGGS.
The nest is built close to the water, as the bird has difficulty in walking on land.

The very striking markings on the neck and body of this diver make it one of our most handsome water birds. It is, however, only found on a very few of the most secluded Scottish lochs, and is therefore seldom seen. I have found that those birds which live in places so remote that they seldom see man, are not difficult to photograph. It was so with this diver; I built a hide of rocks, and very soon after I was out of sight the large bird approached its nest. My hide was made in the water, for there was no suitable place on the island to conceal myself, and for a few minutes the diver swam around. Twenty minutes later it left the water, shuffled clumsily towards its eggs, and settled upon them.

The diver had a clever method of disappearing if alarmed; it left the eggs, getting to the water as quickly as possible, and then, stretching out its long neck, it gave a few rapid pushes with its feet and flashed out on to the water. When it was a few yards from the land, it went under, not diving like some birds might do with a big splash, but submerging itself like a miniature submarine, hardly leaving a ripple on the surface. Directly the bird was under it made

BLACK-THROATED DIVER ON HER NEST.

rapid headway ; nearly fifty yards beyond there was the smallest ripple but hardly a sign of the bird, though powerful glasses showed that it had come up for breath. In doing this the head is still kept flat on the water, then once more it goes under. Within a few minutes the diver was several hundred yards from its eggs, and not until it was well away did it show its body.

The cry of the black-throated diver is one of the most awesome sounds to be heard in the country. Many birds which live in desolate places have notes to harmonize with their surroundings. The beautiful notes of the nightingale would be altogether out of place on a wild Scottish moor, while the call of the diver, if uttered in an English coppice, would scare most of the inhabitants, and probably cause them to flee for their lives. The crofters, and some others who live near the divers' haunt, will tell you that the terrible wail of the bird when uttered at night is the cry of a witch as she rides across the sky. Many a shepherd has fled homewards on the dark nights of early spring, when the black-throated diver is flying above the waters of a loch calling to his mate. I knew one instance in which a crofter ran for his life, thinking that the devil himself was chasing him, though the agonized howl from the sky was simply the love-call of the diver ! The bird he was courting was down below on the waters of the loch, and no doubt to her those awful sounds were as welcome as the sweetest notes ever uttered by thrush or nightingale.

Book Reviews.

Final Report of the Royal Commission on National Museums and Collections. Part I. (H.M. Stationery Office. 2s.).

The report under review is in many ways a notable document. In the first place it is inspired throughout by a high ideal of public service—the function of the museum as an instrument of popular education and culture, as well as a storehouse of our national treasures, is never overlooked, and secondly the Commissioners, in making their recommendations, have never lost their grasp of the facts of the situation. Their undoubted zeal to secure the best possible use of the collections and their suitable display in dignified surroundings has not been allowed to run free without just appreciation of the financial situation.

Part I of the Final Report covers the General Conclusions and Recommendations, the case of individual institutions being left for consideration in Part II, which is to be issued shortly. The interim report issued a year ago was reviewed in *Discovery* in November, 1928.

The first point—a serious criticism and one in which most readers with knowledge of our museums will concur—is that co-operation between kindred institutions has too often been lacking and there has been too little interchange of ideas. Especially is this the case as between national and provincial collections. To meet the needs arising therefrom, the Commissioners suggest the institution of a standing commission in respect of all the institutions named in the terms of reference. The functions of such a commission are outlined. It would deal with finance, securing an equitable adjustment of the claims of each institution, and with administration, guiding development and securing co-operation between different institutions. Hardly less important would be its function of stimulating and directing the generosity of public benefactors.

In order to secure the widest possible knowledge and appreciation of the contents of our collections, the Report urges with considerable emphasis the necessity for a great extension of the system of loan exhibits. It is the practice at the Victoria and Albert Museum to release selected objects on loan to outside bodies. This has proved of great assistance to the work of provincial museums. Their exhibits have been supplemented so far as the nature of the collections has allowed, by series of objects which otherwise would not have been accessible to students without the expenditure of considerable time and trouble. It is suggested that the circulation collections should be greatly extended, and that objects from other National collections, which are at present precluded from participating in this scheme, should be added to them.

It is pointed out that this would also assist the several collections in another direction. It would help, to some extent, to relieve the congestion by which the work of the national collections is greatly hampered at the present moment. The question of space is one of the most serious with which our national museums are faced. It necessarily affects the practicability of the admirable recommendations of the Commission as to the better display of exhibits. With these no doubt the directors of the respective galleries and museums will concur while they regret their inability to carry them out in present conditions. Anyone who knows the state of our collections will probably agree that very little can be done without an enlargement of buildings. It is, however, recommended that space might be found for the enlarged Circulation Department by the removal of the Royal College of Art to a site contiguous to the Victoria and Albert Museum. This removal was proposed by an inter-departmental committee seventeen years ago. The need for a separate Ethnographical Museum, and an open-air Folk Museum to preserve a record of the life, art and industry of the people, is also strongly emphasized.

In the matter of loans of exhibits, the Commission has taken a bold step in recommending that the time has now come when Great Britain should make a positive move regarding international loans for exceptional centenary or other special exhibitions. The proposal is opportune in view of the great success of the exhibitions of national schools of painting recently held in this country. It raises grave issues as to the safety of the exhibits which calls for very careful consideration. Also special legislation will be required. As to the effect in promoting friendly international relations, there can be no two opinions and in this the views of the Commission may be heartily endorsed.

Some admirable suggestions are put forward as to securing greater publicity for the various collections and for enabling visitors to make their way about among the objects exhibited. This is a matter in which most of the museums have done admirable work in recent years, but much can still be done.

Finally, as to cost, it will be felt that the Commission has been moderate. Many of the recommendations are matters of improved organization and variation in methods of administration. In fixing the cost of these suggestions at £80,000 per annum, it cannot be said that the Commission has erred on the side of extravagance when the value and extent of the public benefit which would accrue is taken into account.

E. N. FALLAIZE.

The Scientific Examination of Pictures. By Dr. A. MARTIN DE WILD. Translated from the Dutch by L. C. JACKSON, M.Sc., Ph.D. (G. Bell & Sons. 15s.).

Dr. de Wild embodies in this volume the results of an investigation of the pigments used by the Dutch and Flemish masters from the brothers Eyck to the middle of the nineteenth century, and there can be no question that he has made a valuable contribution towards one branch of a subject which has recently come into prominence. Taking minute particles of pigments from works of which the authenticity cannot be in any doubt, he has subjected them to microscopic analysis, and arrived at definite conclusions, which he has tabulated. For example, natural ultramarine and white lead can be found as early as 1430, but cobalt blue does not appear before 1610, and zinc white not before 1780. Facts such as these can undoubtedly be applied to the determination of dates, provided that it is certain that the picture under examination is not a forgery, prepared under conditions which keep the facts in view. One cannot help regretting, indeed, that the printing of information of this kind must inevitably remove some of the obstacles in the way of the clever faker.

A short section of the book, of more interest to the average person, is that dealing with the X-ray photography of paintings. Dr. Martin de Wild reproduces a series of photographs of a picture by Frans Hals in the National Gallery of Scotland. This used to be known as "The Toper," a name for which some justification was to be found in the glass of wine rather awkwardly held in the right hand of the man depicted. Slight peculiarities in the painting led to the taking of an X-ray photograph, and it then became clear that the glass of wine had

been painted over some other object and that a red bonnet concealed earlier brush strokes indicating hair. A further step was the discovery of an etched portrait by Jan van de Velde, of Verdonck, an intimate friend of Hals, made from a painting by Hals of which all trace had been lost. The resemblance between "The Toper" and the etching was noted, and it was decided to remove the overpainting. The result revealed what was evidently the lost original of the etching. Verdonck, in the restored portrait, is holding part of the jawbone of some animal, and the wine glass had been painted in, doubtless by some later hand, with the object of giving the picture a more general appeal, and making it more saleable. Another pair of illustrations show a portrait of a lady by the Dutch painter, Van Bleyswijk. In this the X-rays prove that the very elaborate costume of the original panel had been concealed by a more prim one, and that the face had also been altered so that it had assumed a more attractive expression.

The mass of scientific evidence which is gradually being accumulated by such investigations as those of Dr. Martin de Wild, should be welcomed even by those—and they are not few—who are inclined to resent the suggestion that there can be any close connexion between science and art. The problems presented by an old painting of which the authenticity is in question are frequently so complex that a scientific analysis which is able to clear away some of the doubtful points must be all to the good. It is futile, for instance, for the critics to quarrel as to whether a painting is by Giorgione if it can be proved that some of the pigments used in it were not invented until the nineteenth century. If, on the other hand, the chemists can pass it as definitely of the right period, there is at least a free field for the champions of Bellini or any other painter of the time whose touch may seem to be recognizable. This sort of argument is so obvious to the ordinary unaesthetic person that it would appear to be hardly worth stating. But if one reads much art criticism it is impossible to avoid the impression that some of the writers seem to rely on a kind of divine aesthetic instinct for the genuine thing, an instinct which they are unable to explain to the common crowd, and which accordingly sets them on a pedestal apart.

Science has not yet reached any definite stage in the analysis of this so called instinct, at any rate in individual manifestations. When it does reach such a stage it will probably announce that genuine aesthetic instincts are based on experiences which can be traced and analysed. If, for example, a critic claims to be able to detect unerringly the hand of Vermeer in a doubtful painting, it is merely that he has made so careful a study of Vermeer's work in authentic examples that he is able to recognize his touch as he would a familiar handwriting. And if that is the case he ought to be able to indicate precisely the nature of the touches which he recognizes. A time is probably coming, though it may still be far distant, when an art critic of any standing may be called upon quite definitely to prove any of his assertions. Dr. de Wild's book marks one of the small steps which are leading in that direction.

C. E. HUGHES.

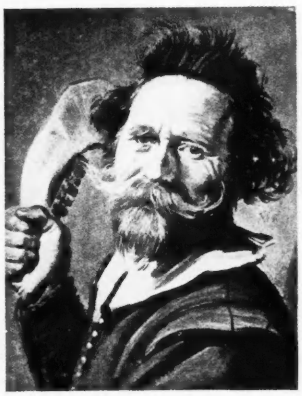
Wales and the Sea Fisheries. By COLIN MATHESON, M.A., B.Sc. (National Museum of Wales. 1*s*.).

Though intended particularly for those interested in Welsh conditions, this little book contains a great deal of matter which should be of interest to a much wider public. The shell-fish fisheries of the Welsh coast, as the author points out, have for long been of considerable importance to the country as a whole, while the development of steam trawling has led to the rise of Milford Haven, Cardiff and Swansea to importance among the great fishing ports. Mr. Matheson, who is keeper of the zoological department at the Welsh National Museum, has had ample opportunities of investigating his subject; and in this book gives us not only a concise account of conditions at the present day, based on his personal observations and studies, but also a historical review of the Welsh fisheries from the era of the Roman occupation onwards. There are also chapters on fishery administration, the whale fisheries, and types of fishing gear—this last chapter, incidentally, would perhaps have been the most appropriate place for the description of the Vigneron-Dahl trawl, which is given instead in Chapter X.

The rapid growth of deep-sea fishery activities in South Wales is one of the most interesting parts of the story which the author has to tell. The three ports already alluded to, which in the early 'eighties of last century did not figure to any great extent in the industry, have to-day between them a total of about one hundred and fifty steam trawlers, many of which work far to the westward of Ireland and shoot their nets in waters approaching two thousand feet in depth. The Welsh vessels are the principal participants in the hake fishery, which though of quite modern growth is to-day of considerable importance.

The chapter on the shell-fish fisheries contains a section on the old mussel-pearl industry at Conway. The author quotes several early references to this fishery, from both scientific and literary sources. It is not improbable also that some of the allusions by Roman writers to British pearls, although he does not mention them, had reference to pearls from Conway among other places—for example, the well-known passages in Pliny (23-79), and in the "Vita Agricolae" of Tacitus.

We have noticed only two typographical errors in the text, and these unimportant ones. The book concludes with a very full bibliography and three statistical appendices. Altogether Mr. Matheson has written an excellent book, interesting not only to specialists in the study of fisheries, but also to all concerned with the economic life of an important part of Britain.



WHAT X-RAYS REVEALED ABOUT "THE TOPER."

A History of Egypt. By JAMES BACKIE, D.D., F.R.A.S. 2 Vols. (A. & C. Black. 36*s.*).

When history really ceases to be a study in water-tight compartments, and it is appreciated that the story of a country lies in the development of its culture as a whole, and not merely or even mainly in a recital of political and military events, Ancient Egypt will come into its own. At present the history of Ancient Egypt has not won its proper place in the process which we call education, or culture, in the broader sense. Egyptology is regarded as the province of the specialist or the dilletante collector of antiquities. Yet until recent discoveries in Mesopotamia, there was no other area in the world which so well afforded a panoramic view in unbroken series of the development of culture from the earliest beginnings to the achievements of Greece and Rome. For the indifference of the general public to the subject, the character of its literature is perhaps to blame.

Dr. Backie's book is a welcome addition to the relatively small number of works which survey the course of events and the development of civilization in Egypt with due regard to the needs of those who are not professed Egyptologists. He carries the story from its inception down to the end of the XVIIIth Dynasty, promising to continue it to the Persian conquest in a later addition. Dr. Backie has dealt skilfully with the numerous difficulties and doubts with which his subject bristles, and although he does not enter into controversy he has, where necessary, indicated the existence and character of opposing views. The difficulty of chronology is met by eliminating dates from the text and giving both systems of dating in an appendix.

Air Pioneering in the Arctic. The two Polar Flights of Roald Amundsen and Lincoln Ellsworth. (National Americana Society, New York).

Though it is not so stated, this beautifully illustrated volume is evidently intended to record more magnificently than did the earlier narratives the achievements and the photographs of the two Arctic flights of Amundsen with his associate Ellsworth, first by aeroplane, and then by airship. Handsomely bound, and of large size, the book contains over seventy collotype reproductions of photographs, and it is these which make the book remarkable, if perhaps too luxurious for the library of the ordinary collector of Polar literature. It must have been a difficult task for the editor to make his selection from the mass of photographical material, but he has certainly succeeded in telling the story by picture. All have points of interest and one or two have artistic merit, though it must be confessed that the Arctic has been less fortunate than the Antarctic in its photographers, nothing of the standard of Ponting's or Hurley's pictures being shown in this collection. The maps, on the other hand, are of the type used in daily papers, and are quite unworthy of the rest of the book.

The text is frankly disappointing. One would have expected a new and revised account of the two journeys mellowed by the perspective of three years lapse of time. But there is nothing beyond extracts from the original narratives by the two men or by other members of the expeditions. The general effect is therefore jerky and journalistic, little in keeping with the standard of the book, or worthy of the two great journeys it commemorates. Indeed, some of the extracts from the papers and speeches on their return detract from, rather than enhance, the great achievements by their lack of balance and judgment.

It seems that the perfervid superlatives of the cinema film advertiser have begun to invade polar literature, and that the inclusion of journalists as members of expeditions has lowered the standard of the narratives. At all events it cannot increase our admiration for the courageous airmen in the "Norge" to have their voyage blazoned in large print as equal to that of Columbus in discovering the New World, or to have a long recital of all the records broken by the explorers. Nor does the solemn statement that "no signs of vegetable life were noted by the Amundsen-Ellsworth-Nobile Expedition" in their voyage over two thousand miles of sea-ice flatter the intelligence of the reader.

One's disappointment at the reading-matter of the book is tempered, however, by the last article, which is a graceful tribute by Ellsworth to his leader and colleague, Roald Amundsen, whose death while endeavouring to succour the survivors of the "Italia" expedition brought a sudden, yet fitting, end to a wonderful career.

FRANK DEBENHAM.

The Four Faces of Siva: The Detective Story of a Vanished Race. By ROBERT J. CASEY. (Harrap & Co. 12*s.* 6*d.*).

The author of this book has been unfortunate in his choice of a title. It does not indicate the nature of his subject, and the catch-penny sub-title may alienate readers who might otherwise have been interested. The author has visited the Cambodian Temple of Angkor Vat and here describes what he saw—not only that marvellous monument of antiquity, in its way a wonder of the world, but also the less known city of Angkor Thom.

The culture is attributed to the Khmers, but what was the origin of this people is uncertain. It is conjectured, and the conjecture is supported by some of the legends Mr. Casey quotes, that they came from India, and that it was the cessation of the invigorating influx from that country which brought the Khmer civilization to an end. Although the remains now known are of very considerable extent, it is probable that more are still hidden in the jungle. Mr. Casey himself claims to have discovered an unknown city, but the conditions precluded more than a partial glimpse of the remains before their exact nature could be determined. The party had to turn to struggle back to its base. Mr. Casey's readers will find they need not fear the tedium of a too minute description of archaeological remains. His narrative is racy and full of colour. Its occasional exuberance finds a justification in the beauty of the numerous photographic illustrations.

The Growth of the World and of its Inhabitants. By H. H. SWINNERTON. (Constable. 5*s.*).

The author tells us in his preface that in writing this volume he "has had in mind not only those whose special interest is in the Nature Sciences, but also those whose studies lie in other directions." He tells us that he feels confident "that they will find in these ideas much that will illuminate their own studies"; and in a total number of less than two hundred pages he has sketched in very rough outline the development and the recent tendency of modern ideas on the growth of the physical world and the world of living things. Space precludes detail, but these chapters constitute an excellent introduction to the study of geology, incorporating as they do reference to the latest work and most important of the latest theories.

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